VISUAL DREAM IMAGERY AND RAPID EYE MOVEMENTS DURING SLEEP

by

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Dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Psychology in the Graduate School of Duke University

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ABSTRACT

(Psychology-Clinical)

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The question of a relationship between rapid eye movements and visual imagery has been a perennial concern in the field of electrophysiological dream research. Recent investigation has focused on the moment-to-moment fluctuation of ocular activity *within* the REM period, and has sought to demonstrate parallel fluctuations in qualitative features of recalled dream imagery. Along these lines, it has been proposed that the dreaming corresponding to ocularly motile segments of the REM period (REM-M) may differ drom dreaming corresponding to the intervening segments of ocular quiescence (REM-Q), with the former being characterized by visual imagery of a particularly salient or vivid nature.

Empirical verification of this notion has been attempted in several studies in which subjects were awakened during REM-M and during REM-Q segments and asked to describe the last recalled dream event

prior to arousal. This approach is rendered problematical, however, by virtue of the relatively brief durations of the respective REM-M and REM-Q segments -- which are typically measured in seconds. Insofar as the real-time location and extent of the "last dream event" is essentially indeterminate this raises the possibility that a subject awakened from a REM-M or a REM-Q segment may report dreaming which actually took place, in full or in part, during the previous contrasting REM segment. Such "contamination" would tend to obscure any relationship which may exist between eye-movement activity and qualities of dream imagery.

In the present study, which attempted replication of pilot findings indicating several qualitative distinctions between REM-M and REM-Q dream reports, this problem was approached systematically based on an analysis of conditions likely to influence the degree of expected "contamination" of dream reports. It was argued that the critical factor here is the degree of temporal separation between the moment of arousal and the previous contrasting REM segment. Accordingly, it was assumed that "contamination" would be minimized when the arousals interrupted relatively <u>long</u> durations of prevailing REM-M or REM-Q, and maximized when <u>short</u> segments were interrupted. This conception dictated four arousal conditions employed in the study: two "low contamination" conditions, which involved interruption of long REM-M

and REM-Q segments (termed ML and QL, respectively); and two "high contamination" conditions, which involved short segments of REM-M and REM-Q (termed MS and QS, respectively). An ML arousal followed upon at least 10 seconds of persistent eye-movement activity, and an MS arousal followed upon no more than 2 seconds of eye-movement activity. QS and QL arousals were carried out, respectively, following 10 seconds and at least 30 seconds of ocular quiescence.

In general, it was predicted that the distinctive qualities of dream imagery associated with REM-M or with REM-Q segments indicated in the pilot study would be present to a higher degree in the dream reports obtained under low contamination conditions (ML, QL) than in those obtained under high contamination conditions (MS, QS). Specifically, it was predicted that REM-M reports (and particularly ML reports) would have a higher incidence of visual imagery, higher visual vividness ratings, more frequent description of "active looking", and more frequent designation of the visual imagery as focally attended to. The REM-Q reports (and particularly QL reports) were expected to contain more reports of thinking, and more frequent designation of thoughts or auditory/spoken imagery as focally attended to.

Six university students served as paid subjects in the study, each spending one adaptation and four experimental nights in the laboratory. Four arousals--one of each type--were scheduled for each experimental night, with the order counterbalanced across the four nights. Upon each

arousal subjects described in their own words that which was recalled as the "last dream event", and this report was then followed by the presentation of a taped set of forced-choice interview questions referring to recalled qualities of the "last dream event". Data for tests of the experimental hypotheses were obtained directly from subjects' responses to interview questions.

In general the results displayed an abundance of inter-subject variance and a relative paucity of significant treatment effects. The main exception to this, however, was the "vividness of visual imagery" measure, which revealed significantly lower ($p < .01$) ratings of visual vividness in QL reports as compared with QS reports, with the latter ratings equivalent to vividness scores associated with ML and MS reports. In addition to this finding there were tendencies ($p < .10$) for ML reports to contain less "thought", and for QL reports to be more often described as focused on thought content. Each of these findings were in the predicted direction.

The results of the study were analyzed along two lines. First, an attempt was made to account for the numerous failures to replicate pilot findings through an examination of several factors possibly contributing to the large inter-subject differences. Discussed here were procedural matters of subject selection, training, and motivation; and in addition three case studies of individual subjects were presented which demonstrate various ways in which intrapsychic conflict can emerge in the course of

such a study and provide a distorting effect on dream report data. From this discussion it was concluded that the present study may inadvertently have entailed a negative bias with regard to tests of the experimental hypotheses.

The second interpretive issue concerned the positive findings relating to visual vividness. These findings were considered with reference to the particular conception of dream recall and dream "contamination" which provided the framework for the study, and it was concluded that some factor conceptually equivalent to the notion of "contamination" is necessary to account for the findings regarding visual vividness ratings. Further, it was suggested that the present model of "contamination" be modified to incorporate the factor of content saliency as an additional determinant of predicted "contamination".

This work is dedicated,

with gratitude and love,

to my parents and grandparents.

S.H. 3/14/77

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S. H.

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CHAPTER I

INTRODUCTION

More than two decades have now passed since Aserinsky and Kleitman's (1953) initial report of the high incidence of detailed dream reports obtained upon arousal from what has come to be known as rapid-eye-movement (REM) sleep, and the relative absence of such reports upon arousal from other phases of sleep. This discovery touched off a flurry of research, still very actively pursued today, which has sought to demonstrate correlations, or parallels, between various physiological events during sleep and post-arousal reports of dreaming.

Over the years physiological sleep studies have demonstrated many complex patterns of change in physiological activity, some involving large temporal segments of sleep that exhibit cyclically recurring configurations of activity (e.g., the so-called REM and non-REM periods), others involving moment-to-moment fluctuations of activity within these larger patterns. Psychophysiological dream studies were at first primarily concerned with the reported experiential correlates of the more <u>macroscopic</u> physiological patterns during sleep, with considerable research devoted to demonstrating the differences between dream

reports from REM and non-REM periods. Recently, however, attention has become increasingly focused on the more microscopic, moment-to-moment fluctuations of physiological activity within the various sleep periods, and dream studies conceived along these lines have sought to approximate, on a similar scale, a description of the moment-to-moment variations in qualitative and quantitative characteristics of reported dream imagery. Whereas earlier the aim was primarily to contrast REM-period dream reports with reports from other sleep periods (Dement and Kleitman, 1957a; Foulkes, 1962; Goodenough, Shapiro, Holden, and Steinschreiber, 1959; Kamiya, 1961; Kremen, 1961; Rechtschaffen, Verdone, and Wheaton, 1963; and others), the more recent concern has been to determine what differences, if any, exist between dream reports obtained upon arousal from different segments within the REM or non-REM periods themselves (Foulkes and Pope, 1973; Molinari and Foulkes, 1969; Pivik, 1971; Rechtschaffen, Watson, Wincor, Molinari, and Barta, 1972; Roffwarg, Herman, and Lamstein, 1974; Watson, 1972; and others).

The present study shares this latter orientation, focusing specifically on the relationship between quantitative variations in eye-movement activity within the REM period and various features of reported visual dream imagery. The question of a relationship between eye movements and visual imagery has been a perennial concern in the field of electrophysiological dream research, a fact which can probably be

attributed to the long-recognized prevalence of visual imagery in recalled dreaming (Ramsey, 1953; Snyder, 1971) and the close associatiation which has long been known to exist between eye movements and visual perception in the waking state (Woodworth, 1938). In this first chapter we will present a review of the main lines of recent empirical research and speculation bearing on this issue and provide thereby the conceptual context within which the present study was conceived and carried out.

The historic report by Aserinsky and Kleitman (1953), in which they present for the first time their findings of an association between rapid-eye-movement activity and detailed dream reports, concludes with the assertion that the observed eye movements, EEG pattern, and associated autonomic nervous system activity are, together with dreaming, very likely all manifestations of a "particular level of cortical activity which is encountered normally during sleep", and that, further, the monitoring of EEG and eye movement activity "furnishes the means of determining the incidence and duration of periods of dreaming". This view was elaborated further in a subsequent publication (Aserinsky and Kleitman, 1955), which also pointed to the preponderance of "strikingly vivid visual imagery" reported upon arousal from eye-movement sleep, and proposed that the rapid eye movements are very likely to be "directly associated with visual imagery in dreaming".

The notion of dreaming sketched out in these early reports, which was subsequently to provide the implicit conceptual framework for much of the psychophysiological dream research over the next ten-to-fifteen years, was developed and tested in a systematic and elegant series of experiments by Dement and Kleitman (1957a, 1957b); Dement and Wolpert (1958); and Wolpert and Trosman (1958). As it developed in the course of these experiments, the main features of their conception of dreaming included the following points: (1) that dreaming is directly limited to the discrete, recurring episodes of low-voltage EEG activity and associated REMs during sleep, with the residual amount of dream recall from outside of these periods attributed to the persistence in memory of previous REM dreaming (Dement, 1955; Dement and Kleitman, 1957a; Wolpert and Trosman, 1958); (2) that dreaming continues throughout the REM period at a pace "comparable to a real experience of the same sort" (Dement and Kleitman, 1957a; Dement and Wolpert, 1958), with different episodes or scenes of the dream being punctuated by gross body movements of the sleeping subject (Dement and Wolpert, 1958; Wolpert and Trosman, 1958); and (3) that the rapid eye movements are specifically related to the visual imagery of the dream such that the frequency, amplitude, and direction of eye movements correspond to the dreamer's looking behavior in response to the dream imagery (Dement, 1955; Dement and Kleitman, 1957a, 1957b; Dement and Wolpert, 1958).

What this view proposed, then, was that dreaming is an intrinsic feature of certain regularly occurring, physiologically distinct segments of sleep, while the observed rapid eye movements represent oculomotor responses to the prevailing configurations of visual dream imagery (Dement and Kleitman, 1957b). Although it was never explicitly stated, the REMs were clearly implied to be a direct result of certain types of dream imagery; specifically, of such visual imagery as would elicit "shifts of gaze" on the part of the dreamer.

The experimental studies on which this view of the REM/imagery relationship was based are quite interesting. Dement and Kleitman (1957a) report an initial attempt to have a subject describe chronologically in what directions he had gazed in the dream, in the hope of matching his report with the observed pattern of eye movements. This proved futile insofar as the subject was unable to recall the dream with such a high degree of precision, and a modified procedure was employed whereby subjects were awakened for dream-content reports as soon as one of four predominant patterns of eye-movement -- vertical; horizontal; both vertical and horizontal; and little or no movement -- had persisted for at least one minute. The dream reports from 35 arousals were then compared with the associated eye-movement patterns -- the latter being unevenly represented due to the relative scarcity of extended durations of pure vertical (n=3) and pure horizontal (n=1) patterns -- and the results were described in an impressionistic, anecdotal fashion. In all cases

of vertical and of horizontal movements the reported dream activity was found to be predominantly in the corresponding spatial plane: vertical eye-movement dream reports involved shooting baskets, looking up and down a cliff, or climbing ladders, while the horizontal eye-movement report was of watching two people throw tomatoes at each other. The awakenings following one minute of ocular quiescence were described as producing reports in which the dreamer was either watching something at a distance or gazing fixedly at some object, while the awakenings after mixed horizontal and vertical eye movements were said to involve reports of watching something or someone close by.

These results were viewed by Dement and Kleitman as highly supportive of an exact parallelism between REMs and visual dream imagery, and two additional studies were carried out to explore this further (both reported in Dement and Wolpert, 1958). One study sought support for the hypothesis that the direction of eye movements are "an exact indication of the direction of dream activity" by comparing the observed last eye movement prior to arousal with the subject's report of his last action -- where he looked -- in the dream. Of 23 dreams judged to be recalled in sufficient detail to differentiate the direction of the last shift in dream gaze, 17 were judged -- by undesignated criteria -- to show a correspondence between the direction of recalled dream action and the direction of the last eye movement. The 74% accuracy figure was interpreted as significantly above a chance level, and the results were considered as

supportive of the hypothesis.

The second study reported by Dement and Wolpert (1958) took a different approach. Citing the extreme variability across REM periods with regard to the amount of eye movement they contain, they hypothesized that the variations in eye movement frequency and amplitude reflect the degree of "active participation of the dreamer in the dream activity", and accordingly, REM periods characterized by frequent and large eye movements would be associated with dreams in which the dreamer is an "active participant", while REM periods characterized by infrequent and relatively small eye movements would be associated with dreams distinguished by "passive participation of the dreamer". Although formal criteria for differentiating "active" from "passive" dreams were not provided in the published report it is clear from the discussion that the determining factor was whether the reported dream activity was of a kind that, had it occurred during the wakeful state, it would entail much ocular activity versus little or no ocular activity. The two experimenters rated 180 dream transcripts along these lines and categorized 109 of them as either "active" or "passive". The two sets of dream reports were then set aside and the associated eye-movement records were independently classified as either "active" or "passive", employing criteria which were again largely unspecified in the published report. Citing the frequent occurrence of several distinct dream episodes in a single REM period, the experimenters rated only the last episode present in the report and only the last 5-10 minutes of the eye-movement

record. Dream-report and eye-movement classifications were then compared and the results were interpreted as clearly supporting the hypothesis that "active" and "passive" dreams are associated with REM periods having high and low levels of ocular activity, respectively.

Taken as a whole, then, the studies by Dement and his co-workers seemed to provide consistent evidence suggesting that both the frequency and the direction of REMs were directly related to qualitative features of the associated dream reports. By contemporary standards, of course, these early studies are open to severe criticism on methodological grounds, most significantly with regard to the many opportunities they provided for the intrusion of experimental bias (Orne, 1962; Rosenthal, 1966) and the inappropriateness of the statistical analyses employed. Nevertheless, the results of these studies -- and particularly the impressive anecdotal evidence cited -- captured the imaginations of early psychophysiological dream researchers and set in motion a controversy which continues to this day regarding the specificity of the relationships between visual dream imagery and REMs (Roffwarg, 1970, Rechtschaffen, 1973). Interestingly enough, virtually all of the subsequent studies bearing on this issue follow either one or the other of the two approaches employed in the early studies by Dement and his colleagues: that is, they focus either on the <u>direction</u> of specific eye movements and specific presumed gaze shifts of the dreamer, or on the general <u>amount</u> of ocular activity and the associated qualitative and quantitative features of the

reports. In reviewing these two lines of investigation we will refer to the former as studies of the "dream-scanning" hypothesis and the latter as the "REM density" literature. Although both approaches were originally inspired by the same underlying conception of dreaming and were at first regarded as alternative tests of the same hypothesis, we shall see that subsequent developments in the larger field of sleep research led eventually to their conceptual divergence and the development of an alternative view of the relationship between dreaming and rapid eye movements.

The first study to attempt a large-scale investigation of the dream-scanning hypothesis was carried out by Roffwarg, Dement, Muzio, and Fisher (1962), who awakened subjects following a variety of different eye-movement patterns and interviewed them in detail regarding "the direction of their gaze and observational vantage point in relation to the objects seen in the dream". From the details of the subject's report an experimenter, blind as to the actual pattern of eye movements prior to arousal, generated a series of predicted eye movements, specific as to their number, direction and timing. Predicted and actual eye-movement patterns were then compared by two judges who rated each pair as displaying either "good", "fair", or "poor" correspondence, employing loosely-defined criteria as a basis for evaluation. The results showed a clear preponderance of so-called "good" match-ups, about 70% overall, and in addition a tendency for the degree of correspondence to be

higher for reports receiving a high confidence rating by the subject (that is, rated as being clearly and vividly recalled). After reviewing a number of factors which might be expected to obscure the relationship between recalled imagery and eye movements, the authors conclude with the belief that were these factors to be eliminated, "accuracy of prediction would undoubtedly approach 100% ".

While these investigations were correct in pointing out the many extraneous factors working against the demonstration of such a relationship, they did not give equal consideration to certain factors which are likely to cause the results to be biased in a positive direction, chief among these being their method of judging the degree of REM/imagery correspondence, which employed judges who were aware of the hypothesis under investigation and who worked directly with the predicted and actual eye-movement data. Two subsequent studies (Jacobs, Feldman and Bender, 1972; Moskowitz and Berger, 1969) attempted unsuccessfully to replicate Roffwarg, et. al.'s findings using somewhat different data-analyses, which included in the latter study an approximation of double-blind conditions for matching predicted and observed eye movements. In their zeal to effect more adequately controlled experimental conditions, however, these studies probably gave inadequate consideration to some of the extraneous factors which could tend to work against the demonstration of the hypothesized relationship such as variations in adequacy of recall, the skill of the interviewer in interrogating subjects and

generating predictions, the choice of awakening times, and so on. In numerous details of the design and execution of these studies there is room for the play of expectations and of personal biases that could have decreased the likelihood of positive outcomes, especially since there is reason to believe that both sets of experimenters were negatively disposed to the dream-scanning hypothesis from the outset.[1] One is left, then, not quite knowing what to make of the conflicting results of these studies; how to weigh the likelihood of false-positive results in the first study against the likelihood of false-negative results in the two unsuccessful replications.

That this issue may already have been clarified empirically is suggested by an as-yet-unpublished study of Bussel, Dement and Pivik (1971), which seems to have addressed most of the methodological problems inherent in studies of the dream-scanning hypothesis, including the particularly sticky ones of obtaining fair assessments of REM/imagery correspondence and of calculating the actual chance level of correspondence for the resulting values to be measured against. The procedure they adopted was to generate predictions of eye-movement direction from the subject's dream reports and then to compare correspondence levels for _actual_ prediction and eye-movement pairs with correspondence levels for three lists of randomly-generated prediction and eye-movement pairs. In this way judges could rate correspondence under

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[1]See, for instance, Berger, 1967, and Jacobs, Feldman and Bender, 1971.

blind conditions since they would not know whether the predicted and observed eye-movement pair being rated were an actual or artificially-generated pair. The results thus obtained showed that prediction accuracy was significantly higher for the actual prediction and eye-movement pairs; and, furthermore, the predictive accuracy for dream reports was indistinguishable from that obtained when the same procedures were employed using awake subjects who reported on their actual recalled visual experiences.

Two additional points in connection with this study deserve mention. First, the focus of analysis was narrowed down to the last eye movement (and presumed gaze shift) prior to awakening, which may have provided a more appropriate and manageable unit to describe -- both for the subject and the experimenter/predictor. Secondly, the authors indicate that the accuracy of prediction was better for "distinctive" eye movements, a statement which brings to mind a similar observation made by Jacobs, et. al., (1972), who report that in cases where the eye movements did seem to follow the visual action in the dream it was usually in connection with an awakening following a single, isolated eye movement. While these observations may simply reflect different degrees of difficulty in demonstrating REM/imagery relationships in regard to single or "distinctive" versus multiple or complex eye-movement patterns, it has also been viewed as suggesting that the 1 : 1 relationship between imagery and eye-movement direction may hold only under certain

conditions and is not a ubiquitous feature of REM dreaming. This modified version of the dream-scanning hypothesis has been suggested by Dement (1967); Jacobs, et. al. (1972); and Roffwarg (1970), and will be considered in more detail later.

In general, then, we may summarize the brief but tortured history of dream-scanning studies by stating that at the present time it appears that under the most propitious of circumstances it may be possible to demonstrate, at a level above that to be expected by chance but well below that of certainty, a positive correlation between the direction of observed eye movements and the recalled direction of gaze of the dreamer. As we shall see, the integration of these conclusions with the larger body of accumulated evidence regarding the phenomena of REM sleep presents somewhat of a problem, one which will be addressed following a review of the second line of REM/imagery research, the eye movement density literature.

The finding by Dement and Wolpert (1958) that high and low amounts of eye-movement activity in a REM period are associated with dream reports rated as "active" and "passive" respectively, was successfully replicated by Berger and Oswald (1962), who employed similar impressionistic methods of determining "active" and "passive" dreams, namely, a subjective judgment as to whether the events described in the dream report "would have been accompanied by many shifts of gaze had they occurred in real life". Despite the high and very significant correlations

reported by Dement and Wolpert and by Berger and Oswald, three recent attempts to replicate those findings (Firth and Oswald, 1975; Hauri and Van de Castle, 1973; Krippner, Cavallo, and Keenan, 1972) have found a considerably lesser degree of correspondence, although in the Firth and Oswald study a "low, but significant" relationship was found in comparisons including the whole night. Each of these studies, in departing from the design of the original studies, employed one or another major methodological change which in some cases were clearly of a questionable nature. For instance, the Krippner, Cavallo and Keenan (1972) study employed but a single subject and determined eye-movement density using a sampling method which has an accuracy of approximately 20%, according to Aserinsky's data (1971). The Hauri and Van de Castle (1971) study, which was of a post-hoc nature, is described in insufficient detail to permit critical assessment, while the Firth and Oswald (1975) study must be regarded as essentially inconclusive, in view of the variety of significant and non-significant results from different comparisons, and the fact that the study included tranquillizer drug and placebo treatments. In addition to these attempts at replication, several other investigators report findings which appear to employ measures similar to the so-called activity/passivity dimension of dream reports. Studies by Kamiya (1962), Goodenough, Lewis, Shapiro, and Sleser (1965), and Hobson, Goldfrank, and Snyder (1965), all found a significant positive relationship between eye-movement

density and the degree of physical activity reported as present in the dream, and it is just this type of content which seems to have been considered in arriving at the original classification of activity or passivity referring to amounts of presumed gaze shift in the dream.

A number of other variables have been reported over the years to correlate with eye-movement density during REM sleep as well. Higher dream-recall rates for high eye-movement density REM periods were reported by Verdone (1965), Hobson, et. al. (1965), Baekeland and Lasky (1968), and Goodenough, Witkin, Lewis, Koulack, and Cohen (1974), while several studies found subjects described as good dream recallers to have higher rates of eye-movement activity than poor dream recallers (Lewis, Goodenough, Shapiro and Sleser, 1966; Baekeland, 1970; Baekeland and Lasky,. 1968), although a significant finding in the opposite direction was reported by Antrobus, Dement, and Fisher (1964). Goodenough, et. al. (1965b) have also reported a significant correlation between REM density and the percentage of awakenings yielding reports of "thinking" rather than "dreaming". In addition to these recall measures,eye-movement density during REM sleep has been found to be positively correlated with reported emotionality (Verdone, 1965; Hobson, et. al., 1965; Karacan, Goodenough, Shapiro and Starker, 1965; Goodenough, Witkin, Koulack and Cohen, 1975); vividness (Verdone, 1965; Hobson, et. al., 1965); bizarreness (Goodenough, et. al., 1965b; Verdone, 1965); visual imagery (Goodenough, et. al., 1965b); and degree

of involvement of the dreamer in the dream events (Hauri and Van de Castle, 1973).

It may be noted that the qualitative features of dream reports shown to be correlated with eye-movement density go beyond what would be predicted solely on the basis of the dream-scanning hypothesis. There is no reason to assume, for instance, that dreams which are more vivid, or more emotional, or better recalled, should necessarily involve more "looking" behavior on the part of the dreamer (and thus more REMs). Furthermore, it should be recognized that even the correspondence demonstrated between eye-movement density and presumed visual activity of the dreamer stands independent of the dream-scanning hypothesis, for there is nothing in these data which would allow one to infer that the observed REMs represent the dreamer's gaze shifts in "looking at" the visual dream imagery.

This point becomes more salient in the light of accumulating evidence which tends to cast doubt on the tenability of the dream-scanning hypothesis, at least as far as it purports to be an explanation of <u>all</u> REM activity. Most compelling in this regard has been the demonstration that REMs occur during sleep under conditions unlikely to support concurrent visual imagery and "gaze shifts". Regular REM periods have been found in both full term and premature human neonates (Parmelee, Wenner, Akiyama, Schultz, and Stern, 1967; Roffwarg, Muzio and Dement, 1966), despite the fact that visual fixation and pursuit movements

are slow to develop over the first several weeks of life. In addition it has been shown that REMs occur in at least some subjects who have been blind since birth and who report no visual experiences in their dreams (Amadeo and Gomez, 1966; Gross, Byrne and Fisher, 1965), as well as in dark-reared kittens (Fishbein, Schaumberg, and Weitzman, 1966). Supporting evidence from experimental animal preparations indicates that bursts of REMs persist even following total decortication (Jouvet, 1970), and, in addition, there is one report of REMs being observed in decorticate (hydranencephalic) human infants (Pierce, Mathis and Jabbour, 1965).

Another set of findings which has been cited as inconsistent with the dream-scanning hypothesis pertains to a number of differences which have been demonstrated between ocular activity in wakefulness and in REM sleep. It has been reported, for instance, that rapid eye movements during sleep, in contrast to waking eye movements, have a lower velocity (Jeannerod, Mouret, and Jouret, 1965) and show a marked orderliness with respect to both temporal pattern (Aserinsky, 1971) and predominant direction (Jacobs, Feldman and Bender, 1971). This argument has been placed in proper perspective by Rechtschaffen (1973) and by Roffwarg (1970), who point out that the peculiarities of sleep REMs could conceiveably be due to the peculiarities in the way dream imagery unfolds and presents itself, and thus it is not necessary that sleep and waking eye movements be identical in form for them to be identical in function.

Nevertheless, the very orderliness of REM phenomena during sleep, in addition to their ontogenetic and phylogenetic distributions, convey a strong impression that the eye movements may reflect a basic biological function which is independent of any specific correspondence they may have with visual dream imagery. Such a view of REMs as causally independent of visual gaze shifts could in addition accomodate the fact that REMs are found in some circumstances where we may presume an absence of visual imagery.

Drawing largely upon an increasing body of experimental evidence pertaining to variations in physiological activity during REM sleep, Aserinsky (1967) suggested an alternative conception of rapid eye movements, which regarded them as one among many manifestations of transiently increased (phasic) levels of central nervous system (CNS) and autonomic activity within the REM period. Aserinsky proposed a conception of the REM period as comprised of two distinct substages corresponding to the alternating segments of ocularly motile (REM-M) and ocularly quiescent (REM-Q) activity present during emerging stage 1 sleep, with each substage corresponding to a distinct "level of cerebral organization". This conception was based on the large number of psychophysiological measures that had already been shown to vary transiently in conjunction with eye-movement bursts, a list which over the years has expanded to include respiration rate (Aserinsky, 1965; Hobson, et. al., 1965; Shapiro. Goodenough, Biederman, and Sleser, 1964; Spreng, Johnson and Lubin,

1968), pupillary dilation (Berlucci, Moruzzi, Salvi, and Strata, 1964; Hodes, 1964), peripheral motor activity (Baldridge, Whitman, and Kramer, 1965), intra-aural muscle twitches (Baust, Berlucci, and Moruzzi, 1964; Roffwarg, Adrien, Herman, Lamstein, Pessah, and Howe-Anders, 1972), spontaneous electrodermal responses (Broughton, Poire, and Tassinari, 1965; Spreng, et. al., 1968), depression of the H-reflex (Hodes and Dement, 1964), alpha frequency EEG activity (Aserinsky, 1965), and tonic EMG suppression (Pompeiano, 1967). In addition to these psychophysiological correlates of REM bursts, there is also a growing body of literature based on animal preparations which describes a number of phasic CNS events, localized for the most part in the visual system, which have been found to be temporally correlated with eye movements. Such phasic events include the monophasic ponto-geniculo-occipital (PGO) spikes observed in the cat by Mouret, Jeannerod and Jouvet (1963) and others, an increased rate of unit discharge in the visual cortex (Evarts, 1962; McCarley and Hobson, 1970), and hyper-excitability of the superior colliculus and optic tract (Munson and Graham, 1971), to name a few. An extensive review of such findings can be found in Pompeiano (1970).

The clear physiological distinction between REM-M and REM-Q episodes led Aserinsky to indulge in some rather bold speculation to the effect that these segments of REM sleep may differ psychologically as well. Citing the "different conditions of cerebral activity", he postulated

that the REM period "may constitute two different levels of dreaming correlated with the quiescent (Q) and the motility (M) segments, respectively. The Q dreaming would be poor pictorially and not easily recalled. On the other hand, the M dreaming corresponding to the phasic neural discharges might represent a level closer to the waking state and would be characterized by stronger images and easier recall" (p. 346).

This new conception of dreaming differs from the earlier notion based on the dream-scanning hypothesis in at least two important respects. First, the new conception proposes a completely different account of the relationship between eye movements and dream imagery. Aserinsky rejects the notion that the REMs represent oculomotor responses to changing dream imagery, asserting instead that the two -- REMs and imagery -- are both independent manifestations of a third factor, a central mechanism or "CNS trigger": 'When some central mechanism excites the cerebral cortex to reach the M dreaming level, that same mechanism directly or indirectly fixes the oculomotor nuclei to give rise to rapid-eye-movements" (p. 346). In Aserinsky's view, visual dream imagery is neither necessary nor sufficient for the occurrence of REMs, and his schema can thus accomodate the previously mentioned instances where REMs appear in the presumed absence of visual imagery.

The second major distinction between the two concepts is with regard to the qualitative description each provides of presumed dream

experience itself. The dream-scanning hypothesis, as elaborated by Roffwarg, et. al. (1962), views dreaming as essentially "an ongoing and continuous sensory experience", corresponding in time to the duration of the REM period, which involves a continuity of visual imagery irrespective of the momentary level of ocular activity. In contrast, Aserinsky describes the dream process in terms which emphasize the inherently varying qualities of dreaming during REM sleep:

> In this schema, a 20-minute REM period does not signify a 20-minute dream, but rather a waxing and waning of cerebral organization with an alternation of strongly and poorly remembered thoughts and images....An analogy to describe the events within the REM period would be one in which an individual is watching television which is turned on intermittently. Fragments of the same or of different stories may follow each other (p. 346).

While the dream-scanning conception views visual imagery during ocularly quiescent segments of REM sleep to be qualitatively similar to dreaming during ocularly motile segments, differing only in the lesser amount of scanning eye movements elicited by the associated imagery in the former, the view proposed by Aserinsky suggests that the segments of ocular quiescence are characterized by little or no visual imagery, and represent a marked contrast to the intermittent bursts of eye movement and their associated vivid visual imagery. In this view the apparent continuity of a subject's dream narrative upon awakening "...does not preclude the strong possiblity that he is stringing together somewhat discontinuous data, employing the logic of the waking mind to force a 'story' from this material" (p. 346).

The new conception of dreaming proposed by Aserinsky, which has come to be identified as the "tonic-phasic model" (Grosser and Siegel, 1971), would thus attribute the vivid visual imagery characteristic of dream reports obtained upon arousal from REM sleep to certain segments of the REM period only, namely those indexed by the presence of rapid-eye-movement activity. Accordingly, we would expect that REM periods differing from one another with respect to the relative proportion of REM-M and REM-Q segments would show corresponding differences in certain qualitative features of reported dream imagery; and, in addition, Aserinsky raises the question as to whether we might expect dream reports from ocularly quiescent sleep <u>outside</u> of the REM period to be qualitatively similar to the dream imagery presumed to be associated with ocularly quiescent segments <u>within</u> the REM period. [1]

Empirical evidence consistent with the former prediction has already been presented in connection with the eye-movement density studies, which have produced a number of qualitative report correlates of REM-density level including activity, vividness, bizarreness, emotionality, visual imagery, involvement, and recall rate, all of which tend

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[1] A careful reading of Aserinsky's paper (especially pp. 338-339) leads me to believe that this latter prediction was put forth with specific reference to non-REM segments characterized by a stage I EEG pattern -- i.e., sleep onset periods -- and was not necessarily meant to include other non-REM sleep stages as Molinari and Foulkes (1969, pp. 347-348) would lead us to believe. For the purposes of this review, however, we will adopt their more inclusive interpretation of Aserinsky's prediction insofar as the data on sleep onset dreaming is relatively scant.

to be rated higher in dream reports from REM periods possessing a high level of eye-movement activity.

Evidence bearing on the second prediction may be inferred from studies which compared dream reports from REM and non-REM periods. A number of such studies, carried out in the late 50'S and early 60's, sought to test the claim advanced by Aserinsky and Kleitman (1953) and by Dement and Kleitman (1957a) that dreaming is confined exclusively to the REM period. While subsequent studies were unanimous in confirming the high incidence of dream reports from REM sleep, many reported a markedly higher incidence of non-REM dreaming than in the earlier studies (Foulkes, 1962; Foulkes and Rechtschaffen, 1964; Goodenough, et. al., 1959; Goodenough, et. al., 1965b; Kamiya, 1961; Kales, Hoedemaker and Jacobson, 1963; Rechtschaffen, et. al., 1963). Employing generally less stringent criteria as to what constitutes a positive dream report, these studies cite non-REM recall rates ranging from 23% to 74%, which is in strong contrast with the low incidences reported in the early studies from Kleitman's lab and confirmed in an independent series of studies by Kremen (1961). The non-REM dream reports have met various interpretations over the years, ranging from the contention that they are experimental artifacts (Kremen, 1962) to the assertion that they represent bona-fide dreaming during non-REM sleep which is often phenomenally similar to REM dreaming (Foulkes, 1967). One general point of agreement, however, has been that the typical non-REM dream report is different from

the typical REM dream report, both quantitatively and qualitatively (Monroe, Rechtschaffen, Foulkes and Jensen, 1965). Foulkes (1962) was the first to report such differences, which included the presence in REM reports of more organismic involvement in affective, visual, and muscular dimensions, and a higher degree of elaboration. Non-REM reports, in turn, were characterized by the frequent occurrence of "thinking" and a closer correspondence to the waking life of the dreamer. Similar findings were reported by Goodenough, et. al., (1965), and by Rechtschaffen, et. al., (1963), who describe the typical non-REM report as "more poorly recalled, more like thinking and less like dreaming, less vivid, less visual, more conceptual, under greater volitional control, more plausible, more concerned with their contemporary lives, ...less emotional, and more pleasant". Dream reports from the sleep-onset period have generally been found to be intermediate with regard to these variables (Foulkes and Vogel, 1965; Foulkes, Spear and Symonds, 1966; Molinari and Foulkes, 1969) but still distinguishable from REM dream reports (Vogel, Barrowclough, and Giesler, 1972).

It will be noted that these qualitative differences between REM and non-REM dream reports are strikingly similar to the differences reported for high and low eye-movement density REM dream reports, which tends to provide additional support for Aserinsky's contention that the particularly distinctive features of REM dreaming may be associated specifically with the episodes of ocular motility (REM-M) within a REM period. With regard to the visual imagery, which is of particular

interest to us here, the evidence from REM/non-REM studies suggests that although visual imagery is found to be more often present -- and more consistently present across subjects -- in REM reports, it is by no means alien to non-REM reports, particularly those from sleep-onset periods (Foulkes, 1962; Foulkes and Vogel, 1965; Goodenough, et. al., 1965a; Molinari and Foulkes, 1969; Pivik, 1971; Rechtschaffen, et. al., 1963). Several studies have indicated, however, that a more detailed inquiry will demonstrate a number of qualitative distinctions between visual imagery reported from REM and from non-REM awakenings, with REM visual imagery being more often described as "clear" or "vivid" (Foulkes, 1962; Rechtschaffen, et. al., 1963), of an "hallucinatory" quality (Pivik, 1971), involving "observed movement" (Pivik, 1971), and containing "scene shifts" (Foulkes, 1962). Again, these findings would appear to be generally consistent with the qualitative differences characterizing high and low eye-movement density REM periods.

Despite this impressive array of indirect evidence supporting the new conception of dreaming introduced by Aserinsky, it is clear that the ultimate test of his proposal would of necessity entail a comparison of reports which represent the recall of dreaming presumably occurring during the segments of REM-M and of REM-Q, respectively. Only then could one address the hypothesis that each of the two physiological conditions are associated with reported dream imagery which is qualitatively distinguishable from that of the other condition, the notion basic to

Aserinsky's view of dreaming as involving a "waxing and waning" of imagery.

To Aserinsky (1967), the likelihood of carrying out such a test of his hypothesis seemed remote as he was doubtful that dream reports could be obtained which are confined exclusively to either the quiescent or motile segments of the REM period. His skepticism was not shared by Molinari and Foulkes (1969), who adopted the procedures initially employed in studies of the dream-scanning hypothesis that involved awakening subjects from periods of ocular activity and ocular quiescence within the REM period and asking them to report the very last preawakening event remembered. The presumed rationale behind such a procedure is that in asking subjects to focus on the apparent last dream event it raises the likelihood that the report will refer to phenomenal events experienced during the target REM-M or REM-Q segment interrupted by the awakening. While this assumption has served to open an important set of phenomena to empirical investigation, it also entails a number of rather serious conceptual and methodological problems which researchers in this area have so far not explicitely addressed themselves to. Insofar as the present study employs the same basic procedures, these problems will be considered in some detail later in this chapter as well as in Chapter IV.

The study conducted by Molinari and Foulkes (1969) was designed to be a test of both suggestions made by Aserinsky: "that (1) episodes

of stage REM marked by ocular quiescence and those characterized by ocular motility may be associated with qualitatively distinct dream activity and (2) periods of ocular quiescence within and outside of stage REM may be associated with qualitatively similar dream activity" (p. 347). Accordingly, the qualitative distinctions they expected to find between REM-M and REM-Q reports were initially conceived of in terms which had emerged from previous comparisons of REM and non-REM dream reports. They then refined these distinctions on the basis of a post-hoc scanning of their obtained reports from REM-M and REM-Q arousals, thus rendering their study a descriptive one only, and arrived at a dichotomous categorization of dream recall referring to the presumed last dream event, in which reports were rated as either containing "secondary cognitive elaboration (SCE)", or, if not, as consisting of "primary visual experience (PVE)". A report was judged to involve SCE if it included any of the following: (1) evidence of active intellectual processes within the experience reported, such as thinking, interpreting, or being aware of something; (2) mention of conceptual relationships, alternatives, or comparisons; or (3) verbalization on the part of the dreamer or words used by another dream character for purposes of explanation. A dream report which showed no evidence of such content would be classified residually as PVE.

Employing this rating scheme three judges rated as PVE or SCE dream reports obtained from 20 arousals following upon an eye-movement

burst (REM-M), 20 arousals following upon at least 30 seconds of ocular quiescence within a REM-period (REM-Q), and a total of 120 arousals from non-REM sleep stages. The results indicated a rather clear-cut and statistically significant differentiation between groups of REM-M and REM-Q reports, with REM-M reports being rated as 88% PVE and 12% SCE as compared to 20% PVE and 80% SCE for the REM-Q reports. As expected, non-REM reports were found to differ significantly from REM-M reports but not from REM-Q reports. Despite the admittedly tentative nature of these findings (due to the post-hoc revision of classification criteria and the small samples of REM-M and REM-Q reports) the authors strongly suggest that the dream experience accompanying eye-movement bursts is intensely visual and unaccompanied by any "cognitive elaboration" while dreaming during inter-burst intervals of ocular quiescence is distinguished in turn by the presence of cognitive activity, and they propose that their PVE/SCE dichotomy be taken as a psychological counterpart to the REM-M/REM-Q description of the physiology of REM sleep.

In an earlier paper (Herman, 1973), this investigator took issue with the PVE/SCE dichotomization on both conceptual and empirical grounds, arguing among other things that the designation of PVE as a residual category precludes the examination of qualitative features of visual imagery which the authors clearly rely on in their description of presumed REM-M dreaming. Thus, by virtue of their affinity for

dichotomization, Molinari and Foulkes find themselves in a position where they are designating REM-Q dreaming as characteristically cognitive despite the fact that 60% of their REM-Q reports contain visual imagery, while REM-M dreaming is cited for its "pre-emptory" and "intense" visual imagery solely by virtue of the fact that cognitive activity tends to be absent from subjects' spontaneous REM-M dream reports.

Because of this and other inadequacies of the PVE/SCE construct, a study was designed and carried out (also reported in Herman, 1973), utilizing an alternative set of dependent measures that were felt to be conceptually more appropriate. Three types of measures were employed, with the first consisting simply of questioning the subject, subsequent to his spontaneous dream report, regarding the presence or absence of five separate experience modalities: visual, auditory/spoken, kinesthetic/tactile, cognitive, and affective. Of particular interest were the visual, auditory/spoken, and cognitive modalities, as it was felt that Molinari and Foulkes' omission of specific inquiry regarding the latter two categories may have resulted in an underestimate of their prevalence in recalled REM-M dreaming.

The second group of measures were designed to assess certain qualitative features of visual imagery in instances where such imagery was reported to be present. Here subjects were asked (1) to rate the vividness of visual imagery, using a 5-point scale adapted from Betts' scale of mental imagery vividness (Betts, 1909); (2) to determine whether

they were "actively looking" at anything in particular or whether they were aware of the visual scene as a background or setting only; and (3) to state whether the visual imagery included any apparent movement and/or abrupt scene shifts.

The third type of measure requires a bit more explanation insofar as it represents an alternative conceptual approach to the distinction Molinari and Foulkes were attempting to capture with their PVE/SCE categories. This measure was aimed at assessing the <u>relative predominance</u> of the various experience modalities reported as present in the last dream event, and was built upon the notion that in dreaming, as in wakefulness, the contents of awareness often present themselves simultaneously through a manifold of different experience modalities. Though at any given moment a number of contents may be present in awareness in a variety of modes, the over-all quality of that moment is generally dominated by some limited part of the whole array of awareness such that one is "focused" on some things and only marginally aware of the rest. This focus-margin configuration, so elegantly described by Titchener(1919) and William James (1924), would appear to be an inherent "structure" of consciousness which any description of a recollected moment -- be it a moment of dreaming or of wakefulness -- would have to take into account, and in the study being described it was extended to include a focus-margin hierarchy of those experience modalities described as present in the last dream event. Thus, at the end of each

interview subjects were asked to determine what, of all they had described as being present in awareness, their attention had been primarily focused on just prior to being awakened, and which modality seemed to predominate at the last moment.

Using this set of dependent measures, a small-scale study was carried out in which five clinical psychology graduate students served as subjects, each of whom spent two nights in the laboratory during which they were awakened under REM-M or REM-Q conditions from all but the first REM period of the night. Upon arousal, the subjects were asked to describe in their own words what, if anything, had been present in their awareness just prior to arousal, and then this report was followed by a structured interview administered by the experimenter.

Because of the small sample size and the inadequate experimental controls which prevailed -- economic factors having dictated that arousals and interviews be conducted by the same experimenter -- the results obtained were represented as being highly tentative and requiring more stringent replication. Briefly, it was found that visual imagery was more often described as present in reports from REM-M arousals (REM-M: 91%; REM-Q: 65%) while cognition, or thinking, was more likely to be described as present in REM-Q reports (REM-M: 29%; REM-Q: 60%). The findings for the "focal" designation were similarly divided, with REM-M reports showing a higher frequency of "visual focus" (REM-M: 58%; REM-Q: 11%) while REM-Q reports more often described

the cognitive or auditory/spoken modalities as focal: cognitive (REM-M: 14%; REM-Q: 37%) and auditory (REM-M: 16%; REM-Q: 47%). Finally, with regard to the various qualities of visual imagery assessed, it was found that the visual imagery reported for REM-M arousals was described as more vivid and more often involving "active looking": mean vividness ratings (REM-M: 3.75; REM-Q: 2.31) and "active looking" (REM-M: 82%; REM-Q: 25%).

In comparing these results -- their tentative nature notwithstanding -- with those reported by Molinari and Foulkes (1969), there appears to be general agreement concerning the relative predominance, or "focal" quality, of visual imagery in reports from REM-M arousals, and of cognitive or verbal contents in REM-Q reports. Furthermore, these data provide support for the notion that the visual imagery as characterized in REM-M dream reports is qualitatively different from that described in REM-Q reports, with the former being more vivid and involving more active looking at some feature of the visual scene and the latter being typically described as a vaguely defined image of the visual setting or background of the dream scene.

One significant discrepancy in the results of the two studies concerns the obtained <u>incidence</u> of reported auditory/spoken imagery and of cognitive content in REM-M reports. Molinari and Foulkes report an incidence of only 6% for each category while our findings were 33% for auditory/spoken imagery and 29% for cognition. Although variations

in criteria no doubt account for some of the discrepancies in the two sets of figures, one must also consider the fact that, whereas Molinari and Foulkes had raters score reports for the presence of cognition or verbalization, our data were derived from subjects' own responses to direct inquiry concerning the presence or absence of these types of content. It would thus appear that had Molinari and Foulkes questioned their subjects more specifically they would have obtained a much higher incidence of "secondary cognitive elaboration" from REM-M reports, and that this would have led to a very different conclusion regarding the appropriateness of the PVE/SCE dichotomization they proposed.

This reassessment of the implications of the Molinari and Foulkes study was conceived and implemented prior to the publication of several studies by Foulkes and his associates which attempted, unsuccessfully, to replicate the original findings regarding PVE/SCE (Foulkes and Pope, 1973; Foulkes, Sheperd, Larson, Belvedere, and Frost, 1972; Medoff, 1972). The most systematic of these (Foulkes and Pope, 1973) included in their post-report inquiry a number of questions which specifically probed for the presence or absence of thinking and of auditory imagery, and separate PVE/SCE ratings were obtained using the spontaneous reports only (as in Molinari and Foulkes, 1969) and the spontaneous reports plus inquiry data. The latter procedure was reportedly inspired by Medoff's (1972) finding, consistent with our own (Herman, 1973), that subjects who are asked specifically will report

an increased amount of conceptual activity upon arousals from REM-M segments. The replication using the original procedure did produce a significant difference in PVE/SCE between REM-M and REM-Q reports, but the figures obtained for SCE (0% for REM-M, 37% for REM-Q) are quite lower than the earlier figures (12% vs. 80%, respectively) and can hardly be interpreted as supporting a dichotomization. In contrast, it was found that when inquiry responses are considered, the incidence of SCE rises considerably, to 64% for REM-M and 75% for REM-Q, which again provides little support for the PVE/SCE distinction. These results led Foulkes and Pope to adopt a view similar to that laid out in our description of the "focus-margin" structure of consciousness, in which the high incidence of cognitive content obtained upon direct inquiry is seen as evidence that conceptual activity as well as visual imagery may be present in both REM-M and REM-Q segments, while the fact that cognitive content is spontaneously reported by the subject primarily upon REM-Q awakenings is considered a reflection of its greater relative saliency at these times. Thus, Foulkes and Pope are led to conclude that "...what Molinari and Foulkes seemed to present as an absolute dichotomy is really a relative gradation of the prominence of thought-like activity within stage-REM" (p. 115, emphasis mine).

To this statement it may be added that our own results suggest that a similar conception may apply to the visual imagery during REM sleep, and, further, that the waxings and wanings over time of the visual

imagery and thought-like content appear to be negatively correlated with one another and paralleled by variations in degree of associated eye-movement activity across the REM period. Thus it appears that in the presence of phasic activation, as indexed by eye-movement bursts, the visual imagery is ascendent, being maximally vivid, focally attended, and actively "looked at". During segments of ocular quiescence, on the other hand, the visual imagery, although often present, is relatively impoverished with respect to vividness and figural content, and attention is more likely to be focused on thoughts or on auditory imagery or verbalization. What is new about this conceptualization is (1) that it regards visual and cognitive content as being present in both REM-M and REM-Q segments (a position sustained by empirical findings reported by Foulkes and Pope, 1973; Foulkes et. al., 1972; Pivik, 1971; Salzarullo and Cipolli, 1974), and (2) that it describes the distinction between REM-M and REM-Q dream reports in terms of characteristic qualitative features of the visual and cognitive elements in each.

In order to explore the presumed relationship between dream imagery and rapid eye movement further, a more extensive study was designed with two purposes in mind, the first of which was to attempt a more stringently controlled replication of the initial findings (Herman, 1973) which had provided the empirical basis for the above reconceptualization. The second intention was to carry out a test of an additional hypothesis which developed out of a systematic analysis of an inherent

theoretical problem in psychophysiological dream research, namely the problem of temporally localizing the presumed experiential referent of the dream report. Although there exists some evidence indicating that subjects can provide judgments of subjective temporal qualities of dreaming, which show a correlation with objective temporal indices such as duration of REM period (Dement and Kleitman, 1957a) or the presentation of external stimuli (Koulack, 1968), the level of specificity of these judgments is quite crude, and the relationship between subjective "dream time" and objective clock time remains essentially indeterminate. This issue, which has previously drawn comment from dream researchers (Berger, 1967; Rechtschaffen, 1967) as well as philosophers (Malcolm, 1959; Ayer, 1962) is one which is particularly critical as it pertains to the so-called "microscopic" studies of dreaming and, specifically, to those which seek to demonstrate some variant of the "two-level" conception of REM dreaming introduced by Aserinsky (1967).

It may be recalled that Aserinsky expressed doubt that his speculations could be experimentally verified in view of the problems involved in obtaining dream reports pertaining strictly to either M- or Q-segments of REM sleep. Although he did not elaborate further on the problem, it is clear that what concerned him was the relatively brief duration of REM-M and REM-Q segments and the likelihood this entailed that dream reports from REM-M awakenings, for instance, might incorporate elements recalled from previous Q-segments. To the extent

that M- and Q-segments are presumed to be associated with different "levels" of dreaming, such reports would be "contaminated" and would not accurately reflect the quality of dreaming present during the interrupted segment itself. The fact that this kind of phenomenon had been observed in non-REM arousals following REM periods by many minutes (Dement and Kleitman, 1957a; Wolpert and Trosman, 1958) must have made it seem inevitable that considerable contamination would occur within the REM period where the alternating M- and Q-segments are measured in seconds. The strategy adopted by Molinari and Foulkes (1969) of asking the subject to report only the "very last event" prior to awakening, though it is a procedure with considerable face validity, does not in fact eliminate the problem of contamination insofar as there is no a priori reason to assume that the recalled dream contents designated as the "last dream event" actually occurred during the time period immediately prior to arousal. The apparent appropriateness of the subject instructions does not insure that the introspective task can be carried out effectively, and neither is there any direct way to verify the reports observationally. Thus, contamination must be accepted as an inherent factor in these studies, one requiring systematic evaluation. Previous studies for the most part have either ignored the problem or dealt with it by making a point of selecting subjects likely to be "highly introspective" dream recallers capable of accurately carrying out the difficult recall tasks involved (Molinari and Foulkes, 1969; Foulkes and

Pope, 1973). Again, though this would appear to be an appropriate procedure to follow it still does not address the real problem, which is how to demonstrate more conclusively that the qualities reported upon arousal from a particular segment of REM sleep actually refer to qualities of dreaming present during <u>that</u> segment and no other.

A way of approaching this problem was arrived at through a deductive analysis taking as its point of departure the following two assumptions: (1) that potential contamination, which is rooted in the indeterminateness of the relationship between dream time and real time, is an unavoidable factor in dream reports and (2) that the likelihood of <u>actual</u> contamination increases as the temporal parameters of the distinct sleep segments become smaller. In the so-called "microscopic" dream studies, the first assumption takes recognition of the fact that the temporal boundaries of the "last dream event" can be specified only subjectively and cannot be related objectively to the units of "real time" employed in physiological measurements (such as durations of eye-movement activity). The second assumption addresses the practical implications of this temporal indeterminateness, and states that <u>actual</u> contamination -- that is, arousals from one segment of sleep producing reports containing content which actually occurred in a previous, contrasting sleep segment -- is more likely to occur the closer the moment of arousal is to the preceding sleep segment. In the case of non-REM reports, for example, it was found that reports of dreaming were more often obtained

from non-REM arousals less than 5 minutes after a preceding uninterrupted REM period than from similar arousals 10 minutes or more after a REM period, and these results were seen as reflecting increasing contamination of the report in proximity to the previous contrasting sleep segment [1] (Wolpert and Trosman, 1958).

In the present case, then, what we are assuming is that though we do not know for certain just when in objective time the recalled dream events designated by the subject as the "last event prior to arousal" occurred, we can be more assured that it occurred some time during the interrupted REM-Q segment, say, and not during a preceding REM-M segment, if there was a substantial duration of REM-Q immediately prior to arousal. On the assumption that REM-Q and REM-M segments are characterized by distinctive "levels" of dreaming which persist <u>throughout their duration</u>, we would not predict any substantive contamination of the dream report -- the temporal indeterminateness of the "last dream event" notwithstanding -- so long as the recalled events referred to in the report occurred <u>some time during</u> the interrupted M- or Q-episode. The effect of increasing the duration of an M- or Q-segment prior to its interruption for a dream report is thus to render more remote any potentially contaminating dream elements from the previous contrasting segment and thereby to decrease the likelihood that they will

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[1] This finding is presented for purposes of illustration only. The results are admittedly open to alternative interpretations.

be recalled as present in the "last dream event".

Empirical support for this notion may tentatively be taken from a number of experimental studies of memory functioning, perhaps the most pertinent being Yntema and Trask's (1963) studies of recall of temporal information, or "recency judgments". In their procedure subjects were presented with a long series of unrelated words on cards and periodically asked to judge which of two test words had been presented more recently in the series. The results clearly indicated that the greater the actual separation between the test items, the more accurate were the associated judgments of recency, and this finding has since been replicated for temporal judgments involving visual material both simple (Fozard, 1970) and complex (Guenther and Linton, 1975). To the extent that the designation of the "last dream event" prior to arousal may be seen as analogous to a recency judgment, then, we may expect to find a similar enhancement of discriminative "accuracy" associated with increased temporal separation of presumably contrasting dream elements.[1]

What we have arrived at, then, is a way of predicting the relative likelihood of contamination effecting dream reports: namely, by varying

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[1] I would hasten to point out, however, that the view of dream recall elaborated here is based on a limited subset of known memory processes, and that other phenomena of memory could as well be applied, some of which would lead to fundamentally different predictions regarding dream recall. These will be considered in more detail in the final chapter.

the duration of target REM-M or REM-Q segments prior to arousal. Thus, all other things being equal, we would expect to find less contamination if subjects are awakened following longer durations of ocular activity or of ocular quiescence and more contamination following shorter durations of the respective REM segments. To the extent that the main hypothesis holds true, that REM-M dreaming and REM-Q dreaming are each qualitatively distinctive, we would expect that under conditions of low contamination (longer durations) the expected qualities would be more clearly present in both REM-M and REM-Q dream reports than they would in REM-M and REM-Q reports obtained under conditions of high contamination (shorter durations). Conversely, should such an outcome in fact be obtained it would represent compelling evidence in support of the main hypothesis concerning the distinctiveness of REM-M and REM-Q dreaming, since the systematic nature of the findings would dictate the necessity for some such distinctive attributes of REM-M and of REM-Q dreaming.

One final issue remains to be settled before this analysis can be operationalized, and this concerns the designation of appropriate durations of M- and Q-segments to be used for the high- and low-contamination conditions. Ideally, one would want to select values which represent relative extremes of short and long segments, but logical as well as practical considerations dictate that durations be selected which are neither so long as to be infrequent occurrences nor, in the case of

quiescent segments, so short as to be confused with the inter-eye-movement intervals present within a REM burst. Fortunately, Aserinsky (1967; 1971) has published detailed normative data regarding the parameters of eye movement activity and quiescence, thus permitting an educated estimate of appropriate M- and Q-durations. These data reveal a bi-modal distribution of inter-eye-movement, with one curve representing the distribution of within-burst intervals (mode: .25-.50 sec.) and a second curve representing the between-burst intervals (mode: 8-16 sec.). These data led Aserinsky (1971) to suggest that an inter-REM interval of 8 seconds be considered the minimum criterion for a REM-Q segment. Using this and other figures as a guideline, durations of 2 and 10 seconds were arrived at as limits for short and long segments of REM-M (hereafter referred to as "MS" and "ML", respectively) while durations of 10 and 30 seconds were selected for short and long segments of REM-Q ("QS" and "QL", respectively).

In the following two chapters we will describe the procedures and results of a study designed to be a rigorous and systematic test of the conception of REM dreaming originally presented by Aserinsky (1967). This test will be organized around the following two hypotheses:

I. Dream reports obtained upon arousal from segments of REM sleep characterized by the presence of rapid eye movements (REM-M) differ qualitatively, in a number of specific respects, from similar dream reports obtained upon arousal from segments of REM sleep characterized

by the absence of rapid eye movements (REM-Q).

II. The qualitatively distinct features of REM-M and REM-Q dream reports will be present to a higher degree in reports obtained upon arousal respectively from long durations of ocularly active REM segments (ML) and from long durations of ocularly quiescent REM segments (QL) than in reports obtained upon arousal from short durations (MS, QS) of the respective REM-M and REM-Q segments.

The specific qualitative features predicted to discriminate REM-M and REM-Q reports are based on the findings of our previous study (Herman, 1973). It is expected that REM-M reports, as opposed to REM-Q reports, will have a higher incidence of visual imagery, higher visual vividness ratings, more frequent description of "actively looking" at something, and more frequent designation of the visual imagery as being focally attended to. The REM-Q reports, on the other hand, are expected to contain more reports of thinking and more frequent designation of the thoughts and the auditory/spoken imagery as being focally attended to.

Expanding these predictions to include the high (MS, QS) and low (ML, QL) contamination conditions, we arrive at the following set of predictions:

Variable	Over-all M vs. Q	Low vs. high contamination -M-	-Q-
Visual imagery present	M > Q	ML > MS	QL < QS
"Active looking"	M > Q	ML > MS	QL < QS
Visual vividness	M > Q	ML > MS	QL < QS
Visual focal	M > Q	ML > MS	QL < QS
Thought present	M < Q	ML < MS	QL > QS
Thought focal	M < Q	ML < MS	QL > QS
Aud./spoken present	M < Q	ML < MS	QL > QS

CHAPTER II

METHODS

Subjects:

The six people who served as subjects in the study, three males and three females, were all Duke University students ranging in age from 21 to 25. They were selected from a pool of 92 applicants responding to signs posted in several campus buildings, advertising the availability of paid positions as sleep-study subjects. The first step in the selection of these subjects from the larger group of applicants was a preliminary screening based on information supplied on the Sleep Study Application Form, a copy of which will be found in Appendix A1. Criteria for selection included the following: (1) age, (with persons 21 and over given priority); (2) flexibility of the person's evening and early morning work or class schedule, (with priority given to those with minimal time constraints) and (3) the absence of specific contraindications such as current physical or emotional problems, medication use, reported sleep disturbance (e.g., difficulty in falling asleep or returning to sleep when awakened), and lack of spontaneous dream recall (less than one dream a week). The results of the initial subject screening procedure

are summarized in Appendix A2.

Following the initial screening, prospective subjects meeting all criteria were interviewed by the experimenter. A preliminary written description of the experimental procedures, a copy of which will be found in Appendix A3, was given to prospective subjects and questions were answered as they arose. Further information of the kind referred to in the sleep study application was obtained in the course of the interview and, in a couple of cases, this provided the grounds for excluding a subject from further participation for failure to meet the screening criteria. The first six people interviewed who met the minimal criteria were accepted as subjects, and all those accepted agreed to participate. The terms of employment were as described in the Information for Prospective Sleep Study Subjects Sheet (Appendix A3).

<u>Subject Preparation and Data Recording Procedures</u>:

Each subject spent a total of five non-consecutive nights in the laboratory, the first of which constituted an adaptation night designed to familiarize the subject with the experimental setting and procedures. On this night and on the subsequent four experimental nights, a subject was asked to report to the lab approximately one-half hour before his or her usual bedtime, and to refrain from using alcohol, coffee or drugs during the day. Upon arrival at the lab, <u>S</u>s prepared for bed and electrodes were then attached for electroencephalographic (EEG) and

electro-oculographic (EOG) recordings. The EEG was recorded from a single silver-disc electrode placed at the vertex, referenced to the right or left mastoid. The EOG was recorded separately for each eye in a bipolar arrangement, with Beckman miniature electrodes attached just outside the inner and outer canthi of each eye, as close as possible without interfering with the lid movement. The electrodes at the inner canthi were placed just above and those at the outer canthi just below, the intercanthal line (the level of direct forward gaze) so as to enhance their sensitivity to vertical components of eye movement. Initial resistances of all electrode pairs were kept below 10,000 ohms.

Upon completion of electrode placement on the first night, the experimenter read to the subject the following instructions:

> As you have already been told, the main purpose of this first night in the laboratory is to familiarize you with the setting and procedures of the experiment -- to give you a chance to become comfortable here before we procede with the main part of the study. Accordingly, you will be awakened only once, and this will be at the very end of the night.
>
> It will be helpful, however, to use this one awakening as a practice run: that is, to treat it as if it were an experimental awakening. For this purpose I will go through with you now all of the procedures which will be followed on the four subsequent experimental nights.
>
> The purpose of this study is to determine what occurs in awareness, if anything at all, at various moments in a night's sleep. We are specifically interested in finding out what you might have been experiencing, if anything, just prior to being awakened by the tone. For this reason we ask that on hearing the signal-tone you awaken at once, say "I'm awake", and immediately recall as clearly as possible what, if anything, you were conscious of <u>just before the tone sounded</u>. That is, concentrate on recalling what might have been going on, if anything at all, just prior to your hearing the tone and waking up. For

our purposes it is most important that you try to distinguish that which was was going on immediately prior to the signal from that which might have been present some seconds earlier. As soon as you are ready to report, do so without waiting for a request from us, and report whatever it is that you recall in as much detail as you can and in your own words. Remember, however, that we do not necessarily want you to report everything that you may recall as having happened while you were asleep, only the last event before the signal tone interrupted you. If, on the other hand, you recall nothing at all happening during this period just prior to the signal tone, then report just that, that you were aware of nothing at all happening. We are looking only for a careful description of what you recall being aware of just before the signal sounded, whatever that may be, and even if it be that you were not aware of anything at all.

When you have finished your report let us know and we will play a set of pre-recorded interview questions for you to answer.

The interview will include four types of questions. One group will be concerned with determining the presence or absence in your report of particular kinds of psychological content -- visual content, auditory or spoken content, thoughts, physical sensations, and emotions or feelings. The questions will be of the following form: "Just prior to arousal, were you aware of any physical sensations, or were you not?" Your task will be to answer each of these questions independently with either a "yes" or a "no".

A second group of questions will require that you rate your degree of confidence in the "yes" or "no" answer you gave to the questions of the first group. To illustrate, after answering "yes" or "no" to the question of whether you were or were not aware of seeing anything just prior to arousal, you will be asked to rate, on a three-point scale, your feeling of certainty that the answer you gave was accurate. On this scale a rating of 3 will signify "very confident", 2 will signify "fairly confident", and 1 will signify "not confident".

A third group of questions will seek further descriptive ratings of two of the content categories, if these categories are judged present in your report. With regard to visual content, if you stated that just prior to arousal you were aware of seeing something, you will be asked to determine further whether or not at that moment you were aware of "actively looking at something in particular". The pertinent distinction is between "seeing something" as a relatively passive awareness of visual content, and "looking at something" or "watching something", which

involves active effort and attention being directed at what is visually apprehended. An answer of "yes" to the question, then, would indicate that you recall apparently looking at or watching something in particular just prior to arousal, while an answer of "no" would indicate that although you were aware of seeing something you were not actively looking at anything in particular. If you were not aware of seeing anything at all this question would be irrelevant and need not be answered. A second additional question referring to visual content calls for a rating, on a five-point scale, of the vividness and clarity of what was apparently seen. The scale to be used is as follows: A "five" signifies that what you apparently saw was "as clear and vivid as if it had happened while you were awake and alert"; a "four" signifies that what you apparently saw was "very clear and vivid, but not quite comparable to waking life"; a "three" stands for "moderately clear and vivid"; "two" is "not clear and vivid, but still recognizable"; and a rating of "one" signifies "so vague and dim as to be just barely discernible".

The same five-point scale will be used to rate the vividness and clarity of auditory or spoken content, if content such as that was recalled as being present in awareness just prior to arousal.

The final question in each interview will require that you determine on what your attention was primarily focused just before the signal tone sounded. Here you will be asked to select the one content category which seemed to be most focally attended to just prior to the signal. In other words, in the last moment prior to arousal, were you primarily attending to something apparently seen? Something apparently heard or said? Some thought? Some physical sensation? Or some emotion?

The same set of prerecorded questions will be used after each awakening, with only the order of the questions being changed. Because of this standardized format, some questions may, as we have mentioned, be irrelevant for the particular report you have given, and if this is the case they need not be answered.

The ultimate value of this study will depend of course on the accuracy of your account of your experience or absence of experience prior to being awakened. We have learned, however, that subjective reports of this sort can easily become biased in one direction or another when the person reporting has some preconceived expectations about what he should be experiencing and reporting. Such expectations are bound to be false, however.

for in designing this experiment we have gone to great lengths to rule out the possibility that a subject may come to know the nature of the particular hypotheses which his observations and reports are enabling us to test. In the cause of scientific objectivity we have incorporated procedures such as using standardized, prerecorded interview questions and randomized awakening times, which should eliminate any chance that the subject will be tipped-off or influenced by any extraneous features of the experiment. The one biasing factor that is more difficult to control, however, is the set of ideas about sleep which a subject brings with him into the experimental situation. Most subjects are familiar with at least some of the recent popular and scientific literature dealing with sleep and dreams, and thus may feel that they have a good idea of what it is that we are investigating here. In fact, however, these ideas are bound to be false as well, for the focus of the present study goes beyond anything previously reported in the literature. Any conjecture based on previous studies is likely to be far off base.

We are pointing out the potential problems which may arise from preconceptions on the part of the subject in hopes that you will try to suspend any beliefs or ideas you may have about what you should or should not be experiencing, recalling, or reporting. Your report should reflect only what you actually recall in exactly the way you recall it.

To review, then, when you hear the signal tone sound you are to awaken at once, say "I'm awake" or "OK", and recall immediately what, if anything, you were conscious of just before the signal sounded. When you are ready, report in your own words what you can recall, and when your report is finished let us know and we will switch on the interview tape.

If you have any need to communicate with us during the night just speak out as a microphone will be open at all times.

Do you have any questions?

On subsequent experimental nights a brief form of these instructions was read by the same experimenter,a copy of which appears as Appendix B1. Following the instructions, questions raised by the subject were answered, the lights were then turned out, and continuous electrophysiological monitoring was begun.

Recordings were made on a 6-channel Grass Model 7 polygraph equipped with a specially designed electrode selection panel which permitted independent recording of electrophysiological data from two subjects simultaneously. Each subject slept in a separate, electrically shielded, sound-attenuated room adjacent to the instrument room. The output for each subject consisted of one EEG channel (vertex/mastoid) and two EOG channels (right eye and left eye), which were recorded at a paper speed of 10 mm/sec. Capacitance-coupled preamplifiers were set at time constants of .24 for EEG and .1 for EOG recordings. The brief time constant employed for EOG recordings was chosen to facilitate visual recognition of the _rapid_ components of stage-REM ocular activity by selectively attenuating the effects of the slower eye movements. An event-marker channel recorded the exact onset and duration of the awakening signal, a pure-tone of 400 c.p.s., which had been preset to a clearly audible, but not startling level. The proceedings of each experimental arousal were recorded in full on audio tape for subsequent transcription and analysis.

Experimental Arousals:

Arousals were scheduled for each REM period of the night with the exception of the first period, which is typically brief and has been reported to yield dream recall differing both quantitatively and qualitatively from that associated with subsequent REM periods (Dement and

Kleitman, 1957b; Domhoff and Kamiya, 1964; Goodenough, et. al., 1965b; Kremen, 1961; Shapiro, Goodenough, and Gryler, 1963).

In the present study a REM period is defined as a segment of sleep characterized by (1) the occurrence of intermittent rapid eye movements; and (2) the presence of a mixed-frequency, low voltage EEG pattern without sleep spindles, K-complexes, or sustained synchronous alpha activity or any other evidence of wakefulness. A single REM period may be discontinuous, however, interrupted by one or more segments of wakefulness or by non-REM sleep. Our criterion for defining the limits of a single REM period is based on data presented by Aserinsky (1971) and specifies a maximum limit of 20 minutes between individual rapid eye movements in the same REM period. In other words, distinct REM periods must be separated by at least 20 minutes of non-REM sleep and/or wakefulness.

Arousals were carried out on the occurrence of one or another of four different patterns of eye-movement activity which were defined as follows:

ML (Movement, Long): Arousal carried out upon the occurrence of at least 10 seconds of persistent rapid-eye-movement activity, which was preceded by a 10-second or longer segment of ocular quiescence.

MS (Movement, Short): Arousal carried out upon the occurrence of no more than two seconds of rapid-eye-movement activity, which was preceded by a 10-second or longer segment of ocular quiescence.

QL (Quiescent, Long): Arousal carried out at least 30 seconds after the occurrence of any observable rapid eye movement.

QS (Quiescence, Short): Arousal carried out exactly 10 seconds after the occurrence of any observable rapid eye movement.

One additional requirement for all arousals was that at least one minute elapse between the occurrence of any apparent body movement and an arousal.

The actual moment of arousal within a given REM period was left to the discretion of the experimenter, who strove throughout to arouse the subjects at moments which represented unambiguous occurrences of the target eye-movement patterns. A secondary concern was to equalize, as far as possible, the average elapsed time since REM-period onset across the arousal conditions, insofar as eye movement density (Aserinsky, 1971), as well as certain qualitative features of dream reports (Kramer, Czaya, and Roth, 1974; Verdone, 1965), have been found to vary with time-into-REM.

A repeated-measures design was employed in which each subject was to be awakened on each experimental night under all of the four arousal conditions. The order of scheduled awakenings during the night was counterbalanced for each subject such that each arousal type occurred once in each of the four ordinal positions. In addition, a partial counterbalancing of arousal order across subjects was incorporated in the schedule, to the effect that on each experimental night half of the total number

of each arousal type was assigned to ordinal positions one and two; and half, to ordinal positions three and four. The schedule of arousals can be found in Appendix B2.

Despite our continuous efforts to adhere to the scheduled order of arousals for each night, a number of unforseeable circumstances intruded from time to time, necessitating various ad-hoc modifications in the sequence of arousals. In some cases a scheduled arousal could not be made during a given REM period for one or another reason: either the REM period was unexpectedly brief, or the subject woke up spontaneously one or more times, or the target eye movement pattern did not occur at a time when the experimenter was able to carry out an arousal. In two instances, the arousal signal was presented but the subject did not respond to it. When any of these situations occurred, which they did in 13% of the scheduled arousals, the strategy followed was to carry out the same type of arousal during the next REM period -- thus maintaining the original order of arousals. A second type of situation requiring modification of the arousal schedule involved the six instances where awakened Ss reported that they could recall no dream content. Insofar as the statistical design of the study called for an equal number of content reports from each arousal type the arousals yielding no-content reports were repeated. Where this occurred the strategy followed was to repeat the arousal-type after completing the other scheduled arousals on that night. Any arousals which for one reason or another could not be

"made up" before the night was over were scheduled for the next experimental night after completion of that night's scheduled arousals. The effect of these departures from the orderly schedule was twofold: First, the relationship between REM period sequence and arousal sequence did not remain stable from night to night; and, second, the number of arousals per night did not remain stable. The effects of these irregularities will be further explored in the next chapter.

The usual sequence of events during an experimental arousal were as follows. The experimenter, upon observing the target pattern of eye-movement activity, activated the arousal signal for approximately one second and simultaneously began tape-recording the proceedings. The subject responded verbally that he or she was awake and, when ready, proceded to describe in his or her own manner whatever was recalled as having occurred just prior to arousal. The subjects' responses were monitored by an experimental assistant who was seated in a separate area of the observation room. The assistant, a social psychology graduate student, was not informed of the general or specific hypotheses under investigation or the nature of the arousal conditions employed, and furthermore was not herself conversant with current issues in the field of electrophysiological dream research. The experimental assistant had been instructed to listen to the report and to determine whether in her judgment the subject had identified as such that which he or she recalled as the "last event" prior to the signal. If she judged

it necessary to make further inquiry she would do so at the conclusion of the subject's spontaneous report, using a probe of the following type (via intercom): "What was the last thing you recall just before the tone went off?" In some cases the subject's report left it unclear as to whether there had been recall of any specific content, and in such a case the experimental assistant was under instructions to inquire about the presence or absence of specific content. If the experimental assistant was satisfied that content had been recalled, and the recalled "last event" had been identified as such by the subject, she switched on a tape-recorded set of 15 standardized interview questions which were paced according to the individual subject's speed of response.

The interview questions, which are presented in Appendix B3, were organized around the five experience modalities (seeing, hearing/speaking, physical sensations, thought, and feeling), with a final question addressed to the overall focus of the experience. Each of the five experience modalities was the subject of from two-to-four related questions which constituted a coherent group. A set of five different interview tapes was assembled in which each modality-related group of questions appeared once in each ordinal position. The question regarding relative focus was placed last in each version of the interview as it implicitly calls for a comparison between the five modalities. Each version of the interview tape was used for all arousals on a given night, and each tape was used once for each subject.

The experimental assistant recorded the subject's answers as these occurred, which were later cross-checked from tape recordings. At the end of the taped interviews the subject was instructed that he or she could return to sleep unless there were no further arousals scheduled for that night. At no time during the night did the experimenter himself communicate with the subject, and the double-blind conditions were thus maintained for the duration of the study.

Data Analysis:

Statistical evaluation of the hypotheses under investigation was based on scores derived directly from subjects' own responses to the standard tape-recorded interview under each of the four arousal conditions. For all measures, scores represent a pooling of the four responses given by each subject under each arousal condition. Where the response measure was dichotomous, ie., answered "yes" or "no", or represented a single category choice, as in the focus-of-attention question, the raw scores were derived by summing positive responses for the four observations under each arousal condition. Where the interview responses involved a numerical rating of vividness, the raw scores represent the average of ratings given by each subject under each arousal condition. The raw scores were analyzed separately for each measure using a one-way analysis of variance for repeated measures procedure (Winer, 1962), with comparisons among treatment means carried out

using the t-method for orthogonal a priori comparisons (Kirk, 1968). Although the present design would have been more adequately served by a statistical approach employing multivariate procedures, it was determined that this would be impractical in view of the substantial number of additional subjects which would be required in order to attain sufficient degrees of freedom for simultaneous analysis of the many dependent measures and separate contrasts involved. Insofar as economic considerations limited the possible scope of the experimental phase of the study, we decided to proceed with the present analysis strategy employing univariate procedures, and to adopt an appropriately cautious stance with regard to interpretation of findings. In order to minimize the likelihood of type I error it was decided to limit the hypothesis-testing to the seven dependent measures for which specific predictions had been made on the basis of previous findings: presence of visual imagery; vividness of visual imagery; "active looking"; focality of visual imagery; presence of thought; focality of thought; and focality of auditory/spoken imagery.

A number of additional measures were included in the post-report interview, some in order to disguise the actual focus of the experiment and others -- specifically, the confidence ratings -- for exploratory purposes. Confidence rating scores for each modality were of two types, the first being a simple sum of confidence ratings for the four arousals under each condition for each subject. The second score was derived

by combining the judgment of presence or absence of a particular modality with its associated confidence rating according to the following scheme:

Presence/Absence: (+) (-)	+	+	+	-	-	-
Confidence rating: (3=most confident)	3	2	1	1	2	3
Derived score:	5	4	3	2	1	0

The derived scores for the four arousals under each condition for each subject were then averaged, and the resulting values subjected to the same analysis procedures as for the other measures.

Results for all such additional measures will be summarized in a separate section of the next chapter.

In order to assure the confidentiality of the persons participating in this study, individual subjects will be identified in the following pages by fictionalized initials only.

CHAPTER III

RESULTS

The arousal signal was presented a total of 106 times over the course of the study. On two occasions, both involving the first attempted arousal of the night, the subject did not awaken when the signal sounded and no dream report was obtained. Two additional arousals were found to be invalid upon subsequent examination of the EEG/EOG records and the data from these arousals were discarded. In one of these, a body movement was mistaken for an eye movement and an MS arousal was made two seconds later; in the other, the experimenter erroneously carried out an MS arousal where the schedule called for a QL arousal. Examples of EEG/EOG records which met the criteria for each of the four arousal conditions are presented in Appendix C.

Of the remaining 102 arousals, six were associated with reports which contained no recall of specific content, for an over-all recall rate of 94%. The recall percentage showed little variation across subjects (range: 89% to 100%) and across treatments (range: 92% to 100%), and is consistent with recall rates reported in similar studies (Foulkes and Pope, 1973; Herman, 1973; Molinari and Foulkes, 1969; Pivik, 1971).

Arousals associated with no-content reports were eliminated from further analyses, leaving a total of 96 content reports, four from each arousal condition for each subject.

Results of data analyses conducted on these 96 reports will be presented in four sections here: Section I will describe over-all patterns of content reported in experimental arousals; Section II will focus on qualitative differences among arousal conditions and will include results of statistical tests of the main hypotheses under investigation; Section III will present results pertaining to additional measures included in the post-report interview; and Section IV will address the issue of experimental controls through a post-hoc examination of several quantitative parameters of the arousals.

I. Characteristics of dream reports: General findings:

Table 1 presents total and individual subject ratings for each of the seven dependent variables pooled across arousal categories. In most cases the total ratings for all subjects and conditions are extremely similar to those found in our previous study, the only exceptions being a tendency for subjects in the present study to describe "thought" as the focal category less often (10% vs. 26%) and "visual imagery" as focal slightly more often (42% vs. 34%) than did subjects in the previous study. A casual comparison of subjects' ratings for the respective variables indicates the considerable between-subject differences present for most

Table 1

Qualitative features of dream reports: Over-all ratings by subject.

Variable	Subjects						Total
	O.Z.	S.P.	T.M.	R.T.	P.P.	C.G.	
Visual present	94%	69%	100%	94%	69%	88%	85%
Thought present	25%	31%	94%	38%	56%	25%	45%
"Active looking"	31%	50%	100%	31%	31%	50%	49%
Visual vividness	3.13	3.73	2.88	3.73	2.91	3.29	3.23
Visual focus	56%	13%	50%	45%	38%	50%	42%
Thought focus	0%	25%	6%	0%	19%	13%	10%
Aud/spoken focus	38%	56%	13%	31%	44%	38%	37%

variables, a factor which will be considered in more detail later.

The intercorrelations among the various dependent measures were assessed, using as the unit of analysis the set of ratings given in each of the individual dream reports (n=96) rather than the summed scores for each subject treatment (n=24) used in all other analyses. This was done in order to avoid the potentially obscuring effects of the summing and averaging procedures and, thus, to provide a more direct reflection of the intercorrelations among variables at the level of the individual dream report. The intercorrelations were assessed by computing either tetrachoric or biserial correlation coefficients -- whichever was appropriate for a given variable pair -- and the results are presented in Table 2. Insofar as these coefficients were derived from repeated observations from individual subjects, meaningful significance levels cannot be determined, and the assessment of relationships among variables must necessarily be pursued in an informal, descriptive manner.

Several trends are apparent in the matrix of correlations presented in Table 2, the most obvious being a general tendency for the several visual imagery measures to correlate negatively with the variables related to thought and to auditory imagery, a trend which would appear to be consistent with the notion that the "visual" and "cognitive" modes represent mutually exclusive types of recalled dreaming. The fact that there are marked variations in the magnitude of these correlations, however, suggests the necessity for a more detailed analysis. While it is

Table 2

Qualitative features of dream reports: Intercorrelations.

	VIS.	LOOK	VIVID	V.FOC	THT.	T.FOC
Visual present						
"Active looking"	.95					
Visual vividness	a	.18				
Visual focus	.94	.41	.16			
Thought present	-.08	-.01	-.07	-.14		
Thought focus	-.72	-.43	-.12	-1.00	.66	
Aud/spoken focus	-.22	-.28	-.09	-1.00	-.33	-1.00

[a] A coefficient of correlation could not be computed for this set of variables since vividness ratings were given only when visual imagery was rated as present.

clear that the "thought focal" measure is strongly correlated negatively with the "visual imagery present" and "active looking" variables, the corresponding correlations of these two with the "thought present" measure are very close to zero. Thus, these results would suggest that it is not the mere presence of thought which is incompatible with visual imagery, but rather thought which is rated as the focal modality of the recalled last dream event.

A further trend would appear to be the positive correlations which prevail among the various measures of visual imagery. But here too it is important to note the differences in magnitude, which range from extremely high correlations between the "presence of visual imagery" and the "active looking" and the "visual focus" variables, to very modest correlations between "visual vividness" and the other measures. In the case of "presence of visual imagery" the extreme high correlations reflect the confounding of this variable with the other measures: visual imagery must be rated as present in order for a positive response to be given to the "visual focus" or "active looking" categories, and it might be added that the same confounding holds true for the "thought present" and "thought focus" variables. In spite of this high degree of overlap, the "presence of visual imagery" measure will be analyzed alongside the others as originally intended insofar as it is a measure with a long history of use in dream research and represents a means of comparison with results of earlier studies, as well as with the results obtained

using the other measures of visual imagery employed in the present study. As far as these latter measures are concerned, the intercorrelations are highest between the "visual focus" and "active looking" variables and markedly lower between these two measures and "vividness of visual imagery". This magnitude difference can probably be in part attributed to the dichotomous nature of the former two measures as compared with the ordinal-scale ratings of vividness, but the low absolute correlations with vividness also suggest that this measure is tapping an aspect of recalled visual imagery which is phenomenally distinct from that which is reflected by the other two measures. The "active looking" and "visual focus" variables, on the other hand, appear to overlap considerably, and findings for these variables should be interpreted accordingly.

II. Qualitative features of dream reports: Tests of experimental hypotheses:

Results of analyses of variance for each of the seven dependent variables, together with the individual subject scores under each arousal condition, are presented in Tables 3 through 9. These data provide the basis for the specific tests (summarized in Table 10) of the hypotheses under investigation that were carried out utilizing the following set of planned orthogonal comparisons (C):

C1: (ML + MS) - (QL + QS)

C2: ML - MS

C3: QL - QS

Table 3a

Presence of visual imagery: Subject scores for each arousal condition.

Subject	Arousal condition				Subject Mean
	ML	MS	QL	QS	
O.Z.	3.00	4.00	4.00	4.00	3.75
S.P.	4.00	4.00	1.00	2.00	2.75
T.M.	4.00	4.00	4.00	4.00	4.00
R.T.	3.00	4.00	4.00	4.00	3.75
P.P.	2.00	4.00	2.00	3.00	2.75
C.G.	4.00	2.00	4.00	4.00	3.50
Mean	1.83	2.00	1.67	2.33	1.96

Table 3b

Presence of visual imagery: Summary of analysis of variance.

Source	SS	df	MS	F	p
Subjects	5.883	5	1.167	1.329	N.S.
Treatments	.833	3	.278	.317	N.S.
Residual	13.167	15	.878		
Total	19.883	23			

Table 4a

"Active looking": Subject scores for each arousal condition.

Subject	Arousal condition				Subject mean
	ML	MS	QL	QS	
O.Z.	0.00	1.00	2.00	2.00	1.25
S.P.	3.00	3.00	0.00	2.00	2.00
T.M.	4.00	4.00	4.00	4.00	4.00
R.T.	1.00	1.00	0.00	3.00	1.25
P.P.	1.00	1.00	2.00	1.00	1.25
C.G.	2.00	2.00	2.00	2.00	2.00
Mean	1.83	2.00	1.67	2.33	1.96

Table 4b

"Active looking": Summary of analysis of variance.

Source	SS	df	MS	F	p
Subjects	22.708	5	4.542	5.326	<.01
Treatments	1.458	3	.486	.570	N.S.
Residual	12.792	15	.853		
Total	36.958	23			

Table 5a

Vividness of visual imagery: Subject scores for each arousal condition.

Subject	Arousal condition				Subject Mean
	ML	MS	QL	QS	
O.Z.	3.00	3.50	3.00	3.00	3.13
S.P.	4.25	3.50	1.00	4.50	3.31
T.M.	2.75	3.00	2.25	3.50	2.88
R.T.	3.33	3.75	3.00	4.00	3.52
P.P.	2.50	3.25	2.50	3.00	2.81
C.G.	3.00	3.00	3.25	3.75	3.25
Mean	3.14	3.33	2.50	3.63	3.15

Table 5b

Vividness of visual imagery: Summary of analysis of variance.

Source	SS	df	MS	F	p
Subjects	1.454	5	.291	.731	N.S.
Treatments	4.091	3	1.364	3.428	$<.05$
Residual	5.967	15	.398		
Total	11.512	23			

Table 6a

Visual focus: Subject scores for each arousal condition.

Subject	Arousal condition				Subject Mean
	ML	MS	QL	QS	
O.Z.	2.00	2.00	3.00	2.00	2.25
S.P.	0.00	0.00	0.00	2.00	0.50
T.M.	2.00	3.00	1.00	2.00	2.00
R.T.	2.00	1.00	2.00	2.00	1.75
P.P.	2.00	2.00	1.00	1.00	1.50
C.G.	2.00	1.00	3.00	2.00	2.00
Mean	1.67	1.50	1.67	1.83	1.67

Table 6b

Visual focus: Summary of analysis of variance.

Source	SS	df	MS	F	p
Subjects	7.833	5	1.567	2.564	$<.10$
Treatments	.333	3	.111	.182	N.S.
Residual	9.167	15	.611		
Total	17.333	23			

Table 7a

Presence of thought: Subject scores for each arousal condition.

Subject	Arousal condition				Subject Mean
	ML	MS	QL	QS	
O.Z.	1.00	1.00	2.00	0.00	1.00
S.P.	1.00	0.00	3.00	1.00	1.25
T.M.	3.00	4.00	4.00	4.00	3.75
R.T.	0.00	3.00	2.00	1.00	1.50
P.P.	1.00	3.00	2.00	3.00	2.25
C.G.	1.00	2.00	0.00	1.00	1.00
Mean	1.17	2.17	2.17	1.67	1.79

Table 7b

Presence of thought: Summary of analysis of variance.

Source	SS	df	MS	F	p
Subjects	22.708	5	4.542	5.191	<.01
Treatments	4.125	3	1.375	1.571	N.S.
Residual	13.125	15	.875		
Total	39.958	23			

Table 8a

Thought focus: Subject scores for each arousal condition.

Subject	Arousal condition				Subject Mean
	ML	MS	QL	QS	
O.Z.	0.00	0.00	0.00	0.00	0.00
S.P.	1.00	0.00	2.00	1.00	1.00
T.M.	0.00	0.00	1.00	0.00	0.25
R.T.	0.00	0.00	0.00	0.00	0.00
P.P.	1.00	1.00	1.00	0.00	0.75
C.G.	1.00	1.00	0.00	0.00	0.50
Mean	0.50	0.33	0.67	0.17	0.42

Table 8b

Thought focus: Summary of analysis of variance

Source	SS	df	MS	F	p
Subjects	3.333	5	.667	2.728	$<.10$
Treatments	.833	3	.278	1.136	N.S.
Residual	3.667	15	.244		
Total	7.834	23			

Table 9a

Auditory/spoken focus: Subject scores for each arousal condition.

Subject	Arousal condition				Subject Mean
	ML	MS	QL	QS	
O.Z.	1.00	2.00	1.00	2.00	1.50
S.P.	3.00	3.00	2.00	1.00	2.25
T.M.	0.00	0.00	2.00	0.00	0.50
R.T.	1.00	1.00	1.00	2.00	1.25
P.P.	1.00	1.00	2.00	3.00	1.75
C.G.	1.00	2.00	1.00	2.00	1.50
Mean	1.17	1.50	1.50	1.67	1.46

Table 9b

Auditory/spoken focus: Summary of analysis of variance.

Source	SS	df	MS	F	p
Subjects	6.333	5	1.267	1.781	N.S.
Treatments	.833	3	.278	.391	N.S.
Residual	10.667	15	.711		
Total	17.833	23			

The first comparison (C1) is intended as a test of the first hypothesis: that dream reports obtained upon arousal from segments of REM sleep characterized by the presence of rapid eye movements (REM-M) differ qualitatively from dream reports obtained upon arousal from segments of REM sleep characterized by the absence of rapid eye movements (REM-Q). The test of this hypothesis is thus carried out by the comparison of pooled REM-M means (ML + MS) and pooled REM-Q means (QL + QS). The second and third comparisons (C2 and C3) are intended to test the second hypothesis: that the qualitatively distinct features of REM-M and REM-Q dream reports will be present to a higher degree in reports obtained upon arousal, respectively, from long durations of ocularly active episodes (ML) and from long durations of ocularly quiescent episodes (QL) than in reports obtained upon arousals from short durations (MS and QS) of the respective REM-M and REM-Q episodes. Specifically, the second comparison will test this hypothesis as it applies to long and short REM-M segments, while the third comparison will provide a similar test with respect to the long and short REM-Q segments.

Results of the over-all analysis of variance and the set of planned comparisons for each dependent measure are presented in summary form in Table 10, where it can be seen that of all the measures assessed, the only one to attain a significant F-value for treatment effects was the "vividness of visual imagery" measure. From the results of comparisons

Table 10

Tests of experimental hypotheses: F-values for treatment effects and summary of planned comparisons among means.

Variable	F df=(3,15)	Comparisons (values of t, df=15)		
		C1: (ML+MS)-(QL+QS)	C2: (ML-MS)	C3: (QL-QS)
Visual present	0.31	0.44	-0.62	-0.62
Thought present	1.57	-0.66	-1.85*	0.93
"Active looking"	0.57	-0.22	-0.31	-1.25
Visual vividness	3.43**	0.67	-0.54	-3.09***
Visual focus	0.18	-0.52	0.24	-0.37
Thought focus	1.14	0.00	0.58	1.75*
Aud/spoken focus	0.39	-0.48	-0.51	-0.51

*** -- $p < .01$
** -- $p < .05$
* -- $p < .10$

among treatment means for this variable it appears that the significant treatment variance is attributable to differences between the QL and QS conditions and is in the predicted direction, with vividness of visual imagery being rated lower in reports from QL arousals than in reports from QS arousals ($p < .01$). No significant difference was found in mean ratings for ML and MS arousals, nor any significant difference between means for pooled REM-M and pooled REM-Q arousals. This latter finding most likely reflects the fact that the low ratings for QL reports are to some extent offset by the ratings for QS arousals, which are somewhat higher than those for MS and ML arousals.

Two other comparisons deserve specific mention although in both cases the obtained relationships are relatively weak (p values close to .10). Results of these comparisons suggest that there is a tendency for "thought" to be described as present more often in MS than in ML reports, and for the thought category to be rated as "focal" more often in QL than in QS reports. In both of these comparisons the results were in the predicted direction.

In contrast to the paucity of significant treatment effects in these data, the analyses of variance summaries in Tables 3b through 9b reveal a prevalence of marked inter-subject differences. Four of the seven dependent variables attained F values for subject effects which were significant at levels ranging from $p < .10$ to $p < .01$. The variables which did not contain significant subject effects were "presence

of visual imagery", "vividness of visual imagery", and "auditory/spoken focus".

In summary one would have to say that the results of these analyses provide only very limited confirmation of the predictions made at the outset of the study. Most notable were the complete lack of anything even approaching a significant difference between combined REM-M and combined REM-Q arousals and the lack of any treatment differences at all for four of the seven dependent variables: "visual imagery present"; "active looking"; "visual focus"; and "auditory focus". Positive findings were limited to differences between long and short segments of REM-M and of REM-Q, which are presumed to represent conditions of low and high contamination, respectively. In line with our predictions, reports from the low contamination condition of REM-M (ML) tended to have a lower incidence of thought rated as present while reports from the low contamination REM-Q condition (QL) were found to contain significantly lower ratings of visual imagery vividness and a tendency to cite thought as the focal modality more often.

III. Qualitative features of dream reports: Results for additional measures:

In the course of the post-report interview additional data were gathered for purposes other than the testing of the experimental hypotheses, and the analysis of these data will be presented in summary form here. The additional measures are of five different types: (1) presence/absence judgments for three remaining modalities (auditory/spoken,

physical, and emotion); (2) vividness ratings of auditory/spoken imagery; (3) incidence of "focal" ratings for two remaining modalities (physical and emotion); (4) confidence ratings for the five modalities; and (5) the combined confidence and presence/absence ratings for each of the five modalities.

Table 11 presents a summary of pooled treatment scores for each of the additional measures, while Table 12 presents a summary of separate analyses of variance performed for each measure with the exception of "physical focus" and "emotion focus" which were associated with extremely low incidences of positive ratings.

The results indicate that of the fourteen measures analyzed none showed significant variation attributable to arousal condition, although one measure -- confidence ratings for emotion -- showed a weak treatment effect ($p < .10$). In contrast to this, subject variance tended to be high, with ten of the fourteen additional measures attaining p-values of .10 or lower.

One such negative finding which may be singled out as of particular interest is that involving the vividness ratings of auditory/spoken imagery, which were based on the same five-point scale used to rate vividness of visual imagery. The absence of over-all treatment effects here -- and particularly the close correspondence between mean auditory vividness ratings for QL and QS conditions (3.39 and 3.44, respectively) -- suggests that the differences reported earlier between QL and

Table 11

Additional measures: Summary of mean scores for each arousal condition.

Measure	Arousal condition			
	ML	MS	QL	QS
Presence/absence:				
Auditory	1.33	1.17	0.83	1.67
Physical	2.50	3.17	2.50	2.50
Emotion	1.33	1.00	1.00	0.83
Vividness ratings:				
Auditory	2.96	3.51	3.39	3.44
Confidence ratings:				
Visual	11.00	10.50	9.67	11.00
Thought	9.17	9.00	8.33	8.33
Auditory	10.33	10.17	10.50	10.00
Physical	10.17	10.50	10.17	10.17
Emotion	9.17	10.00	9.17	10.50
Focal modality:				
Physical	0.33	0.50	0.00	0.00
Emotion	0.33	0.17	0.17	0.33
Presence/confid. scale:				
Visual	4.04	4.54	3.79	4.33
Thought	2.00	2.46	2.63	2.42
Auditory	3.13	3.75	3.00	3.13
Physical	1.79	1.67	1.33	2.20
Emotion	1.71	1.33	1.46	1.25

Table 12

Additional measures: Summary of analyses of variance.

Measure	Source	SS	df	MS	F	p
Auditory: presence	Subjects	5.333	5	1.067	1.143	N.S.
	Treatments	2.000	3	.667	.714	N.S.
	Residual	14.000	15	.933		
	Total	21.333	23			
Physical: presence	Subjects	28.000	5	5.600	10.072	<.01
	Treatments	2.167	3	.722	1.300	N.S.
	Residual	8.333	15	.556		
	Total	38.500	23			
Emotion: presence	Subjects	16.700	5	3.342	6.724	<.01
	Treatments	.792	3	.264	.531	N.S.
	Residual	7.458	15	.497		
	Total	24.950	23			
Aud/spoken: vividness	Subjects	10.687	5	2.137	5.149	<.01
	Treatments	1.130	3	.377	.907	N.S.
	Residual	6.228	15	.415		
	Total	18.045	23			
Confidence ratings: visual	Subjects	15.208	5	3.042	8.780	<.01
	Treatments	7.125	3	2.375	1.508	N.S.
	Residual	23.625	15	1.575		
	Total	45.958	23			
Confidence ratings: thought	Subjects	29.208	5	5.842	2.714	<.10
	Treatments	3.458	3	1.153	.536	N.S.
	Residual	32.292	15	2.153		
	Total	64.958	23			
Confidence ratings: aud/spoken	Subjects	40.000	5	8.000	8.780	<.01
	Treatments	.833	3	.278	.305	N.S.
	Residual	13.667	15	.911		
	Total	54.500	23			

Table 12 (continued)

Measure	Source	SS	df	MS	F	p
Confidence ratings: physical	Subjects	46.000	5	9.200	6.273	<.01
	Treatments	.500	3	.167	.114	N.S.
	Residual	22.000	15	1.467		
	Total	68.500	23			
Confidence ratings: emotion	Subjects	50.708	5	10.142	12.208	<.01
	Treatments	7.792	3	2.600	3.127	<.10
	Residual	12.458	15	.831		
	Total	70.958	23			
Presence/ confidence scale: visual	Subjects	4.169	5	.834	.837	N.S.
	Treatments	1.945	3	.648	.651	N.S.
	Residual	14.945	15	.996		
	Total	21.059	23			
Presence/ confidence scale: thought	Subjects	16.000	5	3.200	2.957	<.05
	Treatments	1.271	3	.424	.392	N.S.
	Residual	16.229	15	1.082		
	Total	33.500	23			
Presence/ confidence scale: aud/spoken	Subjects	7.844	5	1.569	1.797	N.S.
	Treatments	2.063	3	.688	.788	N.S.
	Residual	13.094	15	.873		
	Total	23.001	23			
Presence/ confidence scale: physical	Subjects	35.219	5	7.044	12.187	<.01
	Treatments	2.354	3	.785	1.357	N.S.
	Residual	8.677	15	.578		
	Total	46.250	23			
Presence/ confidence scale: emotion	Subjects	15.938	5	3.188	7.501	<.01
	Treatments	.719	3	.240	.564	N.S.
	Residual	6.375	15	.425		
	Total	23.032	23			

QS conditions with respect to visual vividness do not merely reflect a general lessening of imagery vividness during the longer quiescent segments of REM sleep, but rather are modality specific.

IV. Quantitative characteristics of arousal conditions: The adequacy of experimental controls:

It was stated in the previous chapter that efforts were made to control, across treatments and subjects, for time-of-night and for time-into-REM period at the moment of arousal. In light of the difficulties encountered in implementing these controls, analyses of these two parameters were carried out on a post-hoc basis to estimate the direction and degree of any systematic inter-treatment variations. For the purposes of the analyses, time-of-night was defined as the elapsed time between initial sleep onset and the moment of arousal, and time-into-REM was defined as the elapsed time between the first eye movement of the REM period and the moment of arousal minus any intervening episodes of extended wakefulness or descending stage 1 or stage 2 sleep. Results of these analyses are presented in Table 13, where it can be seen that for each of the two measures the means for the MS, QL, and QS conditions tend to be relatively similar while the ML means for the two measures show moderate discrepancies in the direction of earlier time-of-night and longer time-into-REM relative to the other arousal conditions.

Insofar as time-of-night and time-into-REM have been shown elsewhere to be correlated with eye-movement density (Aserinsky, 1971)

Table 13

Mean time-of-night and time-into REM for each subject x arousal condition.

Subj.	Mean time-of-night (minutes)				Mean time-into-REM (minutes)			
	ML	MS	QL	QS	ML	MS	QL	QS
O.Z.	330.5	411.0	421.5	377.0	15.1	8.9	10.4	9.1
S.P.	325.0	376.8	349.0	346.3	8.0	7.3	7.4	7.4
T.M.	299.8	302.5	372.0	347.5	12.6	10.9	8.5	11.1
R.T.	316.0	331.5	323.8	379.3	14.1	7.8	9.4	12.6
P.P.	292.5	292.3	294.8	295.3	10.1	9.1	7.3	7.6
C.G.	361.8	447.5	344.0	359.5	7.0	8.5	8.0	7.8
Mean	320.9	360.3	350.8	350.8	11.2	8.7	8.5	9.3

this raises the possibility that the level of eye-movement activity characteristic of REM periods interrupted by ML arousals may differ from the levels shown by the REM periods in which the other three types of arousal were carried out. This possibility was investigated using as a measure of eye-movement density the ratio of mean REM-M segment length to mean REM-Q segment length in all REM periods interrupted under each treatment condition for each subject.[1] The obtained values for eye-movement density for each arousal condition (Table 14a) were then subjected to an analysis of variance employing the same set of comparisons used in the tests of the experimental hypotheses, and the results are summarized in Table 14b and 14c. As anticipated, eye-movement density of REM periods interrupted by ML arousals tend to be lowest, with the difference between ML and MS conditions significant at the .05 level. It should be noted that the effects of this discrepancy, if any, would be expected to run <u>counter</u> to the hypotheses under investigation,[2] particularly with regard to presumed ML/MS differences, and we should therefore entertain the possibility that these quantitative differences in the interrupted REM periods may have contributed in some degree to the

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[1] Appendix D contains a detailed description of methods and results of quantitative analyses of eye-movement data.

[2] This is based on the fact that REM periods of low eye-movement density have been found to be associated with qualities of recalled dreaming which are contrary to qualities predicted for REM-M -- and particularly ML. These findings have been summarized in Chapter 1.

Table 14a

Mean eye movement density of REM periods interrupted by experimental arousals.

Subject	Arousal category				Subject Mean
	ML	MS	QL	QS	
O.Z.	0.24	0.45	0.52	0.25	0.37
S.P.	.44	.53	.68	.49	.54
T.M.	.33	.37	.35	.44	.37
R.T.	.24	.32	.26	.27	.27
P.P.	.74	1.01	.62	.94	.83
C.G.	.34	.49	.35	.51	.42
Mean	.39	.53	.46	.49	.47

Table 14b

Mean eye movement density: Summary of analysis of variance.

Source	SS	df	MS	F	p
Subjects	.775	5	.155	14.352	$<.01$
Treatments	.061	3	.020	1.892	.17
Residual	.162	15	.011		
Total	.998	23			

Table 14c

Mean eye movement density: Summary of comparisons among means.

Comparison	t	df	p
C1: (ML + MS) - (QL + QS)	-0.353	15	N.S.
C2: ML - MS	-2.333	15	$<.05$
C3: QL - QS	-0.333	15	N.S.

predominantly negative findings with respect to these arousal categories.

One further control issue which was examined concerns the subjects' response latencies upon presentation of the arousal signal; in other words, how quickly they wake up and begin reporting under the different arousal conditions. Several studies have demonstrated a tendency for dream reports obtained upon gradual arousal to be more "thought-like" than those obtained upon abrupt arousal (Goodenough, et. al., 1965a; Kremen, 1963; Lewis, et. al., 1966; Shapiro, Goodenough, Lewis, and Sleser, 1965), and it has been suggested that gradual awakening may increase the chance that subsequent dream reports will include description of hypnopompic experiences occurring subsequent to the arousal signal. In the case of the present study such an effect would have particularly serious consequences for reasons which should be obvious.

Two measures of response latency were analyzed here, both of which were obtained from tape recordings of the arousal proceedings.[1] The first measure, which we will refer to as "initial latency", is the elapsed time between arousal-signal onset and the subject's initial verbal statement indicating that he or she is awake, and the second measure ("report latency") is the elapsed time between signal onset and the beginning of the subject's substantive report of recalled dreaming. With regard to the issue of gradual versus abrupt arousal the initial latency measure must be regarded as the most direct indicator of the rate of

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[1] Measurements of latencies were carried out manually using an electronic sweep-second timer, with values rounded off to the nearest .1 second.

arousal, insofar as subjects were instructed to respond with some verbal signal as soon as they were awake but to begin reporting only when they were "ready to report" -- in other words, when they have decided what to begin describing.

Mean values for initial latencies under each arousal condition are presented in Table 15a, while Table 15b presents a summary of an analysis of variance for these data. It is clear that the mean initial latencies are quite short and that there is no indication of any significant treatment effects.

In contrast to this, the results for report latencies -- which are presented in Tables 16a, b, and c -- indicate a tendency for longer report latencies to be associated with QL arousals ($p < .10$), with the differences between QL and the other conditions being in the eight-to-nine second range. Thus it would appear that although subjects awaken at roughly the same rate under all four conditions -- at least to the point that they can utter a verbal testimony to their awakening -- they tend to take somewhat longer to begin reporting on those occasions following arousal under QL conditions. Possible implications of this finding will be taken up in the next chapter.

Table 15a

Mean initial latencies (in seconds) for each subject under each arousal condition.

Subject	Arousal condition				Subject Mean
	ML	MS	QL	QS	
O.Z.	2.8	3.0	2.2	2.3	2.6
S.P.	5.0	3.1	4.1	3.1	3.8
T.M.	6.1	6.2	4.7	7.6	6.2
R.T.	3.2	2.8	2.8	2.6	2.9
P.P.	3.6	3.1	4.0	3.9	3.7
C.G.	4.0	3.7	3.8	4.3	4.0
Mean	4.1	3.7	3.6	4.0	3.8

Table 15b

Mean initial latencies: Summary of analysis of variance.

Source	SS	df	MS	F	p
Subjects	31.858	5	6.372	17.119	<.01
Treatments	1.117	3	.463	.805	N.S.
Residual	6.938	15	.372		
Total	39.913	23			

Table 16a

Mean report latencies (in seconds) for each subject under each arousal condition.

Subject	Arousal condition				Subject Mean
	ML	MS	QL	QS	
O.Z.	22.1	29.2	33.1	26.8	27.8
S.P.	16.4	23.5	46.8	29.8	29.1
T.M.	34.0	32.0	46.1	27.2	34.8
R.T.	7.5	4.9	4.8	5.9	5.8
P.P.	17.4	16.2	20.5	20.4	18.6
C.G.	16.4	9.4	9.2	9.8	11.2
Mean	19.0	19.2	26.8	20.0	21.2

Table 16b

Mean report latencies: Summary of analysis of variance.

Source	SS	df	MS	F	p
Subjects	2546.254	5	509.251	13.371	<.01
Treatments	247.608	3	82.536	2.167	.13
Residual	571.281	15	38.085		
Total	3365.143	23			

Table 16c

Mean report latencies: Summary of comparisons among means.

Comparison		t	df	p
C1:	(ML + MS) - (QL + QS)	-1.689	15	N.S.
C2:	ML - MS	-0.067	15	N.S.
C3:	QL - QS	1.899	15	<.10

CHAPTER IV

DISCUSSION

In this final chapter, presented in three sections, we will take up and discuss, first, the striking inter-subject variation, already noted in Chapter III but now scrutinized at closer hand and through the presentation of interesting case material; second, certain procedural matters that could have influenced the results obtained; and third, the positive findings, critically examining them for their implications regarding the systematic conception of dream recall introduced in Chapter I.

I.

The figures in Tables 3 through 9 that relate to inter-subject differences provide nothing of the remarkably varied ways the subjects behaved over the course of the experiment. To convey something of these untoward behaviors and, in so doing, demonstrate their possible effects on the results obtained, we will present here three brief case studies of

individual subjects, each of whom displayed a unique style of report behavior and each of whom provides us with very different reasons for questioning the validity of the data they contributed.

Subject R. T.

Two features of R. T.'s report behavior set her apart from the other subjects. First, although she awakened no faster than most of the other subjects, as indicated by the initial latency data presented in Table 15a, R. T. tended to begin reporting almost immediately upon arousal; her mean report latency of 5.8 seconds was more than four times faster than the mean for all the other subjects. Even more important, her report latencies varied very little from arousal to arousal, which would seem to indicate that, regardless of the content involved, R. T. decided quickly what it was she recalled and began reporting it directly. The second unusual feature of her reports was their extreme brevity and lack of detail, with the typical dream report consisting of only one or two short sentences. Initially, this gave the impression that R. T. was either an amazingly efficient and precise dream recaller and reporter, who apparently had simple, straightforward dreams, sparse in detail; or that she, for some reason, was placing a premium on quickness of response as against accuracy of and attention to detail. Not wanting to intrude and thereby perhaps unduly influence her reporting should the former in fact be the case, we let this go on until the third night when the experimental assistant chose to probe a particularly

sparse report, with surprising results, as follows:

R. T.: [3 second report latency] I was, um, writing a note in a notebook to a friend of mine. O.K.[1]

E: Can you give us any more details on that?

R. T.: Uh, you mean like what was going on in the background?

E: Yeah, anything else you might have been aware of at that moment.

R. T.: Well, I was kind of thinking. Yeah. I was thinking. Oh, yeah -- I had my finger over a hole in the paper so that the water wouldn't spout through the, spout out through it. Kind of an odd thing. And the note I was writing was big. Last thing I remember was hearing the pen against the paper, and I remember holding the pen. That's -- I think that's really kind of it.

If this report is any indication of how necessary probing was for this subject, then much of the finer details of R. T.'s dream experiences may have gone unreported and so lost to further scrutiny. The same loss may have applied to the taped interview section as well, for R. T.'s quick style of reporting characterized her responses to these questions too. She invariably presented her ratings immediately and without extended deliberation, and was thus able to return to sleep every time with the minimum possible delay. This fact would suggest that a plausible motive underlying R. T.'s adopted response style may have been the desire to get the task over with quickly and thus hasten her return to

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[1] "O.K." was R. T.'s customary signal that she had completed her report.

sleep. On the other hand, we might speculate that R. T.'s pattern of immediate reporting may have reflected a deliberate strategy based perhaps on the belief that immediate reporting might facilitate recall. This would not, however, explain the persistence of this response style throughout the taped interview section.

An explanation of a different sort is suggested by the bizarre quality and possible sexual connotations of the additional material uncovered by the assistant's probe. If this be any indication of the type of content left unexpressed throughout in the spontaneous reports, then it may be that her lack of attention to detail fulfilled a defensive function for R. T.; a "covering up" in reaction to some implicitly threatening aspect of the experimental situation. In this light her quick and minimally detailed dream report would represent a compromise solution enabling R. T. to nominally fulfill her obligations to the experiment without relinquishing control. Hastening the return to sleep might also be viewed in this regard as fulfilling an essentially defensive function, insofar as extended wakefulness might provide additional opportunity for the uncovering of unwelcome material, and either way we could expect such factors to have a distorting effect on the data contributed by this subject.

Subject T. M.

In marked contrast to the report style just described, T. M. displayed response latencies, of both kind (initial and report), which were about twice as long as those for the other subjects. Not only was this so,

but when T. M. did begin reporting he often rambled and seemed to be confused and quite vague as to the boundaries of the recalled last event. Often during the course of the interview much new material was appended to the report, which gave at times the impression that the recalled dream was being then and there further elaborated or embellished. Consider, for instance, the following report:

> T. M.: [35.5 second report latency] I don't think I perceived anything, but I'm sure of ---- no, I perceived something, but I don't know if I was, I was thinking about ----about, um, ---- oh, I know what I was perceiving, I was thinking about, um, about hiring practices in business. That's it.
>
> E: Can you recall what was happening immediately before the tone sounded?
>
> T. M.: Uh, what had happened was, um, it was a small black business, and with the introduction of a black marketer the, uh, the business seemed to expand of its own accord, whereas standing off and watching what the effects would have been, uh, vis-a-vis a white marketer, things were static. So it was a very much attuned to the, uh, knowledge of the system-type thing. Um, it was more a feeling of acceptance of what was real and true, and it was just a general feeling, I guess.

This report was followed by inquiry material in which T. M. stated that the last event prior to arousal had contained visual imagery, auditory imagery, physical sensations (touch), thought, and emotions, and in addition he reported that he had been looking at something and that the focus of his attention was on something apparently seen. This was a puzzling set of responses given the nature of the initial report, and, at the end of the taped interview, the experimental assistant asked T. M.

to describe again the event he recalled as the last prior to arousal. The description which follows presents a vivid and detailed dream scenario in marked contrast to the initial report:

> T. M.: Yes, um ---- this owner of a black business, he was a big guy, and, um, it was a very well-lighted office, um, back up against a corner, and he was talking with another black guy, and I think he was the marketer. And I really don't know what they were talking about, but it seemed from the second man's presence the first man was, um, kind of reassured of his, um, the business growth. And he was also a little odd because he didn't think that, uh, what he was seeing was true, and the marketer was kind of telling him that this is a natural thing, that it's obvious, and, uh, it's a natural cause of events to, uh, for this to happen, for introduction of, of, uh, a person of one's own race in this position because of his knowledge of the people and the markets and stuff.

The tendencies displayed in this report -- its initial vagueness and subsequent progressive elaboration -- were typical of T. M.'s report behavior and were reflected in a number of ways in the summaries of quantitative ratings from his reports. Compared with the other subjects, T. M. rated as present almost twice as many modalities (mean=3.9) in each recalled last dream event. Moreover, he rated <u>every</u> last event as involving "active looking" as compared to the other subjects for whom the range is 31% to 50%. For him, all last events but one (94%) included thought, as against 25% to 56% for the other subjects. Furthermore, T. M. described almost one-third of his dreams as focused on emotion, whereas only one out of the 80 dreams of the

other subjects was so described.

Such marked discrepancies raise certain serious questions: Could it be that T. M.'s dreams diverge so from the normative? Or, rather, was his recall and/or reporting perhaps different in some way? Intuitively, the latter seemed the more likely, in view of T. M.'s relatively extended arousal latencies and the peculiar way his dream content evolved in the course of a report period. But more dramatic evidence came to hand, of a direct and indirect sort, that warrants description here in some detail.

After the end of the third session, during electrode removal, T. M. remarked apropos of arousals that he seemed to experience a distinct premonition that the arousal signal was about to go off, and that this sense of anticipation was apparently felt within the context of the ongoing dream just prior to the actual sounding of the arousal signal. T. M. was asked to report any re-occurrence of this, and he did so on several occasions the following night. These special reports provide some indication that the sense of anticipation may have been tied up with apparent confusion regarding the sequencing of pre- and post-arousal experiences. Consider, for instance, the following report:

> T. M.: [Initial latency: 6.1 seconds; Report latency: 35.4 seconds] Um ---- right after the tone sounded the last thing that I remember was, uh ---- somebody, uh, yelling about my car not having a license plate and wanting to follow me, so I guess somebody wanted to follow me or something, in another car. I don't know what it was. [emphasis mine]

E: You said "after the tone..." uh, was that what you meant?

T. M: Uh ---- I think I, I could revise that and say that I think it was before the tone, but it was ---- it was the last thing before the tone sounded, is what happened.

The slip, "after the tone", appears very eloquent and speaks almost for itself, the subject's subsequent and seemingly hesitant clarification notwithstanding. In addition, the manifest theme, which involves somebody drawing attention to his lack of a license plate, provides what would appear to be a symbolic expression of the subject's then-current emotional situation. At the time, T. M. was experiencing considerable difficulty in recalling and describing his dreams, and the manifest content of other reports is replete with comparable images of being illegitimate or in the wrong, or having messed up in some way. Examples of this from the third and fourth nights include a dream of being "... in a discussion with some elderly ladies over who had rented a discussion room -- to which we finally acquiesced, being in the wrong"; another of "running to a projector in the back of the room that was completely immersed -- enmeshed with film, the film roll had screwed up"; and a third dream of "...calling my brother to help me perform a little task ... our van had slid down a road and was wedged between a couple of trees".

The preponderance of such material seemed to reflect T. M.'s growing concern over the adequacy and perhaps the legitimacy of his dream reporting, and it is against such a background of feeling that we

may best understand certain events which ensued on the following experimental night when we had the rare opportunity to observe in a dramatic way how the process of gradual awakening could influence the nature of the dream content recalled as present just prior to arousal. On this night T. M. arrived at the lab and apologetically explained that he had not had sufficient sleep lately and that he hoped this would not interfere with his ability to wake up and report when requested to do so. True to his expectations T. M. did not awaken to the signal tone during the first attempted arousal until after a minute had passed, and on the second arousal he was unable to recall any content. By this time T. M. was quite apologetic, despite our assurance that his report had been perfectly acceptable. After yet a third arousal yielded dream recall that was vague and without detail, the next arousal produced the following report:

> T. M.: [Initial latency: 5.3 seconds; Report latency: 31.8 seconds] I was, uh, I was thinking about something that was about to happen. Uh, in the background I was swimming out to a boat and I was ---- I was thinking, uh, it seemed I was just thinking everyday thoughts. But from my vantage point watching myself I knew that, um, I was going to get attacked by a shark, and I was just ---- at that point I was observing myself, and I think the emotion of watching was most prominent.

Consider T. M. at this point in the experiment. He has already "failed" three times tonight and must be under considerable situational stress, not to mention all those serious concerns carried over from previous nights regarding his adequacy. Given also T. M.'s so-called "anticipation" of experimental interruptions it would seem highly likely

that the sudden intrusion of the shark idea and the associated fear of imminant attack at the very end of the dream was in fact a symbolic representation of T. M.'s emotional reaction to the intrusion of the experimental arousal, which was most likely already under way. Further description by T. M. tends to confirm this impression. In response to the primary focus question he cites emotion as the focal modality and explains: "...at the point that the bell ---- the tone came on I think that, uh, I was aware of, um, watching myself, but I think that that's um, background. To a point. Although it carried itself right up until the tone. But I think when the tone rang I was realizing what my fear was and reacting to that primarily".

T. M.'s interview responses, then, were clearly affected by this last item of content, which we have reason to believe represented the intrusion of content generated as an artifact of arousal. This phenomenon, which was first reported in the current dream literature by Kremen (1961), may well provide a paradigm for understanding how T. M. came to rate so many of his dreams as focused on some felt emotion just prior to arousal, for in most of these cases the emotion involved was dread or fear of some sort.

In addition to this possible clarification, the data presented in the case of T. M. serves to point out the difficulty of ridding subjects of their expectations and presumptions concerning what they should be experiencing and reporting. In the present case, for instance, it was clear that T. M. reacted to his lack of recall in disappointment or as a

failure, and, as Kremen (1961, 1963) has so dramatically demonstrated, subjects in such circumstances may well take advantage of any opportunity to seize upon and elaborate any available content. Thus, we might tentatively identify T. M.'s excessive elaboration and apparent over-inclusiveness in describing the last dream event as also representing a certain form of defense, which we may perhaps characterize as an over-compensation for feelings of inadequacy. Furthermore, the saga of T. M. confirms yet another point emphasized by Kremen (1961) and also by Fox, Kramer, Baldridge, Whitman and Ornstein (1968), to the effect that the dream-laboratory situation provides a rich environment for the play of both intrapsychic and interpersonal dynamics, which may have a direct effect on manifest dream content as well as on the quality and quantity of recall. A further illustration of the form such effects may take will be provided by the final case study, that of subject C. G.

Subject C. G.

From the first contact C. G., a graduate student in the natural sciences, struck this investigator as suspicious and a bit uncomfortable in the role of subject, which he had undertaken -- by his own account -- essentially "for the money". During the first night of uninterrupted sleep C. G. showed a tendency toward unstable REM periods characterized by periodic transient awakenings which, in turn, were followed by brief excursions into sleep-onset stage 1 and in some cases non-REM stage 2 before returning to the REM stage. At the same time, C. G. did show

four extended episodes of uninterrupted REM sleep lasting from 10 to 20 minutes each, and, insofar as atypical sleep patterns are often associated with the first laboratory night, no particular notice was taken of the slight tendency toward self-awakenings during stage REM.

On the second night, however, a series of events occurred, which, in retrospect, seems to have touched off what might be described as a condition of significant unconscious conflict that continued to intensify throughout the following two experimental nights and finally seemed to resolve itself by the last session. What transpired on the second night is this: After an uneventful arousal and dream report from the second REM period the subject returned to sleep, completed another cycle, and again entered REM sleep. As the experimenter was busy at this moment conducting an arousal of another subject, C. G. remained in undisturbed REM sleep for 9 minutes at which point he spontaneously awakened and, though it was about 4:30 A. M., he remained awake for approximately 20 minutes before falling back to sleep. About an hour later, as another cycle drew towards completion and the EEG showed the first signs of an incipient REM period, C. G. again awoke spontaneously and again remained awake for an extended period, in this instance for 25 minutes. Following this, the next two-and-a-half hours produced two more REM periods which were interrupted by experimental arousals early in their course.

The dreams reported on these occasions were interesting, and further aroused our curiosity concerning the two earlier periods of extended wakefulness associated with spontaneous awakenings from ongoing

or incipient REM periods. The first dream was of "...walking through a college campus that looked a lot like a high school, looking at the people ...looking to me like their hair was all too short". The second dream was as follows:

> I dreamt that the experiment was over, and these 2 football players came in, and I was sitting in a chair with nothing but a sheet on...what happened was they had just left and I was thinking that I should have picked up a heavy book and threatened to hit 'em in the face with it. And I can't really clearly recall what I was doing when the tone went off, although I can remember things several seconds before that. But that's what I was thinking, and I think that I was moving away. That's about all.

The next morning, as the electrodes were being removed, C. G. suddenly said, "you know, you missed one dream last night". When asked if he recalled what it had been about, C. G. answered, "yes -- it was a very explicit sexual dream", but offered no more information about it. This investigator, curious though he was about the spontaneous awakenings and subsequent periods of wakefulness, chose not to probe further, mindful perhaps of the possible implicit message contained in the last dream of the night, of the hostile intrusion of the football players as the subject sat in the sleep room, naked in a sheet.

The following two nights showed an intensification of the seemingly related patterns of repeated spontaneous awakenings from REM sleep and reported dreams whose content was saturated with representations of interpersonal conflict and thinly-disguised hostility, some of which bore unmistakable references to the laboratory situation. On night three

there were seven separate instances of spontaneous awakenings followed by excursions into sleep-onset stage 1 and stage 2 sleep, and on night four this occurred on eleven separate occasions, not to mention an additional number of gross body movements which represented temporary interruptions of the REM period. As these patterns intensified it became increasingly difficult to carry out experimental arousals as time and time again C. G. would wake up or turn over just as the experimenter prepared to activate the arousal signal. In fact, by night four the whole process seemed to take on the character of a test of wiles, and it was apparent that the subject had arrived at an effective means of forestalling, if not blocking, the experimental arousals. Here again the whole sequence of events had all the feeling of a defensive maneuver, the effect of which was to abort -- for whatever reason -- the carrying out of the data-gathering operations. Although we cannot know for sure we might speculate, on the basis of the reported dream content, that the conflict aroused for C. G. by the experimental situation was of a manifestly sexual nature.

Inexplicably, however, the situation seemed to change markedly by the fifth night, for not only was the incidence of self-awakenings reduced by more than half from the previous night but this was paralleled by a dramatic and very interesting shift in the pattern of dream content. In place of the increasingly populous and highly conflictful dreams of the three previous nights the four arousals on this night were totally devoid of other human characters and all involved placid scenes where the subject is looking at or manipulating various items including a

bicycle (arousal 1), some cans in a box (arousal 2), a group of sheep (arousal 3), and an electric game-board with little plastic football players (!) on it (arousal 4). Clearly, something had shifted with regard to the psychodynamics of the experimental situation for C. G., some resolution had been reached or some alternative strategy employed, and the character of the dream content on this night would seem to suggest that this might have involved a significant degree of withdrawal on the part of the subject.

Whatever the particular source and subsequent vicissitudes of the conflict generated for C. G. by his involvement in the experiment it is clear from these data that this conflict was expressed emphatically both with regard to the observed patterns of sleep and to the reported dream content. The magnitude of these effects are sufficient to call into question the meaning of the data contributed by C. G., particularly as they were gathered from REM periods which showed an unusual degree of fluctuation between episodes of REM sleep, wakefulness and sleep onset stage 1. In this light the fact that it was C. G.'s data which most consistently contradicted the hypotheses under investigation (see Tables 3a through 9a) may alternatively be viewed as a function of the highly unusual physiological and psychological conditions under which they were obtained.

The case studies provided here illustrate a number of phenomena encountered in the execution of the study which may well have had a significant effect on the results obtained -- particularly when we consider

that the three subjects just described contributed exactly half of the total data. Nor were the kinds of phenomena described limited strictly to these three subjects. In fact, of the six subjects only one -- S. P. -- functioned throughout the study in a manner consistent with our expectations based on the performance of subjects in the earlier study. It is difficult to substantiate this impression about S. P. with objective data, other than to note that in all phases of the study, from the initial interview through the final night of data collection she impresssed both the experimenter and the assistant with her uniformly high level of interest and motivation, her clear understanding of the discrimination tasks involved, and her ability to carry these out in an obviously logical and consistent manner. A graduate student of religion, S. P. was in background, training and interests perhaps most similar to the graduate students in clinical psychology who served as subjects in the previous study, and she displayed a familiarity with introspection and the description of dream imagery which may well have compensated for any shortcomings of the training procedures employed in the present experiment (which we shall describe shortly).

The reason for singling out S. P. as an exemplary subject is that in our attempts to draw some conclusions from the results of the present study we place considerable emphasis on various subject factors which may have led to a negative biasing of the tests of the hypothesis under investigation, and the data from at least one subject who impressed us as having remained relatively free from such factors may provide an

indication -- although admittedly a highly tentative one -- of the kind of results which might have been found under more propitious conditions.

The figures presented in Table 17 provide an indication of the extent to which S. P.'s ratings of dream content support the hypotheses under investigation, particularly with regard to the presence of visual imagery, presence of thought, visual vividness and "active looking".

Table 17

Summary of ratings for subject S. P.

Variable	ML	MS	QL	QS
Visual present	4.00	4.00	1.00	2.00
"Active looking"	3.00	3.00	0.00	2.00
Visual vividness	4.25	3.50	1.00	4.50
Visual focus	0.00	0.00	0.00	2.00
Thought focus	1.00	0.00	2.00	1.00
Auditory focus	3.00	3.00	2.00	1.00
Thought present	1.00	0.00	3.00	1.00

It would seem, then, that at least in this one subject there is a distinct difference between the visual imagery as described in REM-M and REM-Q reports, with these differences being most notable in comparisons with figures for QL arousals. Although we must be very cautious in drawing conclusions from the results of a single case removed from

the context of a larger study -- which for all our explanations may easily be explained on the basis of chance effects -- the occurrence of such clear-cut findings reported by a subject who above all others we had informally predicted, prior to the onset of data gathering, to be an excellent and reliable reporter of dream recall, provides the kind of additional intuitive support which encourages us to refrain from accepting the surprisingly negative results of the present study as the authoritative and final word.

II.

In the preceding section, focus fell on the disruptive effects of certain unpredictable individual predispositions apparently intensified in the dream laboratory. We turn next to a critical examination of the experimental procedures themselves.

Consider first two unfortunate but unavoidable conditions inhering in laboratory studies of dreaming: First, that there is no independent verification for the primary datum, the subject's report of recalled dreaming; and second, that when awakening a subject forcefully from sleep we may well then have a person far from his or her best for careful introspection, logical thinking, consistency of judgment, accuracy of recall and whatever else might be necessary for the veridical recall and report of a dream. The dream reporter, as the ultimate source of primary data, is thus placed in a position where much is expected of him or her though ordinarily in similar natural circumstances one would not expect much at all.

This state of affairs becomes even more critical in studies in which the discrimination tasks are particularly complex or subtle, apt to present a significant challenge even under the best of wakeful circumstances. The report task in the present study posed subjects difficulty of this kind, certain features of which we will now scrutinize more closely.

First, subjects were awakened and asked to recall not only _what_, if anything, they had been dreaming but also to recall _when_ that might have occurred, using the arousal signal as a temporal reference for determining the "last dream event" prior to it. This temporal discrimination was in fact an integral feature of the report, for subsequent ratings were to be based solely on the recalled "last event". Furthermore, subjects were asked to describe or rate their recollection not only in terms of _content_ but also with regard to certain _formal qualities_ which included such dimensions as the nature of the sensory, cognitive and affective modalities involved; the recalled vividness of certain types of imagery; and the configuration of awareness at the last moment in terms of its focus and margin. Although these tasks were introduced to the subjects in language as far as possible concrete and non-technical, it could have been that the underlying descriptive concepts were for the most part unfamiliar to them and were perhaps interpreted in varying and unforseen ways. One is reminded, in this regard, of the great pains taken by introspectional investigators -- whether of a structuralist (Titchener, 1898, pp. 32-42) or phenomenological (Zener and Gaffron, 1962) orientation -- to rid

the observing subjects of their habitual patterns of perception and cognition and train them to introspect and report in the desired manner. A small number of studies (eg., Antrobus, Antrobus and Singer, 1964; Foulkes and Fleisher, 1975) have been reported which employed similar interruption procedures and similar kinds of descriptive schema to investigate recalled experience during wakefulness. Although none of the published accounts of these studies contain reference to any significant difficulties encountered by subjects in fulfilling the required tasks, we can point to at least two facilitating factors present during wakefulness which would most likely be absent when the same tasks are applied to the recall and description of dream experience. First, in retrospectively ordering events on the temporal dimension in wakefulness one may rely on very powerful and familiar contextual cues such as cause-and-effect relationships or the logical effects of linear sequencing. Previous experience would indicate, however, that such effects do not necessarily extend to recall of events presumably experienced during sleep -- which are notorious in their impressions of departure from familiar patterns of linear sequencing and logical causality. This problem drew frequent comment from subjects, in both our present and our earlier studies, who on occasion found it difficult to determine with any sense of certainty the very last event prior to arousal or what had been the experiential qualities of that last moment of dreaming. The occasions where this was easiest to determine were at those times when the arousal tone seemed to interrupt a familiar action midway in its anticipated course, such as an

interrupted sentence, which provided a sufficient contextual framework for determining the temporal order of events. The non-completion of an action in these cases provided the cue to the moment of interruption of the dream much as it would in waking life.

The second factor which would facilitate the discriminatory tasks in wakefulness is the well-known enhancement of recallability for items most recently presented, which has been demonstrated in numerous studies of serial-order effects on memory and has led to the postulation of a discrete memory system -- "immediate", or "primary memory" (Waugh and Norman, 1965) -- containing information which seems to have not yet left awareness. This phenomenon may be illustrated by the common experience of being accused, "You're not listening", and happily finding it possible to repeat back word-for-word the last sentence spoken though one had not been paying attention as the words were first said. Were such a capacity to extend to recall of interrupted dreaming it would greatly facilitate the present task, but unfortunately this possibility is counteracted by two related factors. First, the time-constant, or decay rate, for primary memory is relatively brief -- Murdock (1974) estimates it to be on the order of five seconds -- and thus the time involved in the transition from sleep to wakefulness would become critical. Second, and probably more important, is that in general,recency effects are particularly sensitive to retroactive interference (Postman and Phillips, 1965) and, as Giora (1973) and Cohen (1974) have each pointed out recently, the rude transition from sleep to wakefulness provides optimal conditions for the

generation of such interference. In fact, Giora (1973) has discussed, from the point of view of memory consolidation theory, certain findings which indicate that under certain conditions of high arousal present in REM sleep a phenomenon reminiscent of retrograde amnesia can be observed in which more recent material is at a definite disadvantage with respect to recallability.

In recognition of the inherent difficulty of the tasks involved in these so-called "microscopic" studies of dreaming, it has been an accepted procedure for investigators to take the liberty of selecting as subjects individuals who for one reason or another are considered "likely to be adept at introspective discrimination" (Molinari and Foulkes, 1969), although specific criteria for the selction or rejection of a potential subject is not cited. In our pilot study the designation of graduate students in clinical psychology as the subject population was inspired by similar considerations, as it was felt that these students would be interested, well-motivated and highly capable of understanding and carrying out the required introspective tasks. But even here the present investigator found himself being selective as to subjects, employing implicit criteria which would have been extremely difficult to render in replicable operational terms. Although the outcome of this implicit selection process turned out well by providing a group of subjects who performed their tasks capably in all respects, it presented a dilemma when the new investigation demanded the design of a rigorously controlled replication with explicit description of all phases of the experimental procedure -- including that

of subject selection.

At this point a decision was made, influenced no doubt by the clear-cut nature of the pilot findings, to insist on rigor; and an objective, conservative set of subject-screening procedures was adopted (see Appendix A2). In contrast to the practice employed in comparable studies, the present subjects were not selected for their presumed ability at "introspective discrimination", and in subsequent observation of these subjects over the course of the study the investigator became increasingly aware of the wide range of such abilities these subjects displayed and their general divergence from the level of performance displayed by subjects in the earlier study. Examples of the kinds of observations which led to these conclusions have been presented in the case material concerning subjects R. T. and T. M..

There are several additional procedural features of the present study which may have compounded the effects of the subject selection factors and thereby contributed significantly to the over-all differences observed between the report behavior of the present subjects and those taking part in the previous study. The most important of these concerns differences in the form and the extent of specific and incidental instructions given to subjects in each case. In the former study, subjects received a standard set of initial instructions and then were informally briefed in detail regarding the topics to be covered in the interview. The interview itself was conducted according to a flexible and detailed format which in fact amounted to an ongoing "training" process in the kinds of

discriminations being sought, and in addition provided considerable opportunity for feedback and clarification. In the present study, however, such opportunities were drastically reduced, since both initial instructions and the set of interview questions were strictly standardized, with the latter being presented via tape recording, a procedure which clearly discouraged subjects from seeking clarification or feedback concerning their understanding and application of the various descriptive constructs. In the light of the inherent difficulty and subtlety of these tasks it would appear in retrospect that we may have been overly optimistic in expecting all our subjects to provide us with the desired kinds of discriminations and judgments on the basis of formal training limited to a single brief session.

A second procedural factor which may have had a detrimental effect was the tape-recorded format of the interview (see Appendix B3). Several subjects expressed their irritation with the predictable and repetitious style of the recorded interview, and it is reasonable to assume that this tended to decrease the level of subject motivation and engagement in the study, particularly in view of the fact that some subjects seemed at times to drift off during the tape despite its lasting in most cases only about five minutes. Furthermore, the fact that the experiment extended over five nights provided ample opportunity for the compounding of any such effects.

In summary, we have pointed to a number of considerations which contribute to the inherent difficulty of the experimental tasks and, in

addition, have reviewed several procedural features of the present study which in retrospect may have resulted in less than optimal outcomes with regard to subject selection, subject preparation, and the maintenance of subject morale and task engagement. Examples of the varied manifestations of these and other problems have been presented in the three case studies where certain behaviors observed raised serious doubts concerning the validity of the data obtained from these subjects.

From the many considerations presented in this and the previous section it would appear that the design and execution of the present study, with its emphasis on strict control of the possible sources of experimenter bias present in the pilot investigation, may inadvertently have entailed a distinct negative bias with respect to the tests of experimental hypotheses. Thus it would appear most prudent to withhold final judgment in cases where the results of the present study fail to replicate the earlier findings, other than to conclude that the relationships suggested by the earlier findings are not easy to demonstrate, if in fact they exist at all, and to encourage further investigation of these matters under conditions, educated by the lessons of the present study, which seek to optimize the important factors of subject selection, preparation, and maintenance without thereby sacrificing the necessary elements of adequate experimental control.

III.

Concerning the positive findings of the present study, what has been shown most clearly is this: Subjects awakened from REM sleep 10 seconds as compared to 30 seconds or more after the last rapid eye movement rate the visual imagery that is recalled as having been present just prior to arousal as more clear and vivid. Further, the ratings obtained from arousals 10 seconds after an eye movement do not differ from those obtained when arousals are carried out in the immediate presence of eye-movement activity.

That these findings stand alone against a background of predominantly negative findings raises several immediate questions, the first of which refers back to a point raised in the initial discussion of data analysis procedures: Is it not likely, given the relatively large number of individual comparisons conducted in the experiment as a whole, that such a singular finding may be due to chance alone? Although the numerous comparisons in the study admittedly increased the probability of type I error, it remains so nevertheless that the present finding, significant at less than the .01 level, replicates a similarly significant effect in the previous study and that, of all eleven subjects in both studies, only one -- C. G. -- failed to rate visual imagery as more vivid upon REM-M (ML, MS) than upon REM-Q (QL) arousals. It is the consistency of this finding that argues most strongly for its validity.

A second question raised by these positive findings concerns why they were limited to the ratings of visual vividness and not extended to

other measures of visual imagery found in the previous study to vary similarly in M- and Q-reports? The answer to this would seem to lie in the previously discussed factor of subject effects, which were extremely low in regard to vividness ratings ($F=.731$) and relatively high for the measures of "active looking" ($F=5.326$, $p <.01$) and visual focus ($F=2.564$, $p <.10$). On the other hand, the presence of visual imagery was rated positive in the great majority of reports (85% over-all) and this tended to limit the possibility of demonstrating any significant effects for this measure, either for subjects or for treatments. As to why such an attenuation of subject variance was associated with the visual vividness ratings it could well have resulted from differences between the 5-point scale employed in such ratings and the present/absent dichotomization employed in the other measures. One would expect that a 5-point scale, with steps ranging from very vague through moderately vivid to extremely vivid, would tend to call forth a more normal distribution of ratings <u>within</u> subjects and thus minimize mean differences <u>between</u> subjects. In addition the explicit description of scale steps (eg. "5 - as clear and vivid as if it had happened while you were awake and alert") might have provided a much-needed concrete frame of reference against which to judge what was recalled of the vividness of the dream imagery. These characteristics of the vividness rating scale, helpful though they are, do not in themselves rule out strong subject variance, however, for such effects were present ($F=5.149$, $p <.01$), for some unknown reason, in similar vividness ratings of recalled auditory/spoken imagery. It

would thus appear that the present vividness rating scale, adapted from Betts' (1909) scale, is a sensitive vehicle for demonstrating general variations in what is recalled of the vividness of visual dream imagery, and its further use in similar studies is to be recommended.

Before considering the systematic implications of the present findings there is one further issue to be raised regarding their validity. In the previous chapter data were presented that indicate a longer mean report latency (elapsed time from signal onset to the beginning of the substantive dream report) for QL arousals. In the light of the evidence presented by Kremen and by Goodenough and his co-workers (cited in Chapter III) concerning the more "thought-like" character of dreams reported upon gradual arousal, could we not as well attribute the lower vividness ratings of QL reports to artifact generated by more gradual awakening on these occasions? Such an explanation, though plausible, does not appear to be likely, however. As we have already shown, the initial arousal latencies (signal onset to initial verbal response) were very brief (mean= 3.6 seconds) and did not differ from those of the other conditions. Furthermore, a compelling explanation may be suggested, to the effect that the extended report latencies upon QL arousals reflect the <u>increased difficulty of the recall tasks</u> under these conditions, an effect which would be consistent with the lower vividness ratings given to the content recalled. The existence of such a relationship between difficulty of recall and report latency has already been shown in the context of a short-term recognition memory task by Murdock and Dufty (1972), who used subjects'

confidence ratings of their recognition judgments as a measure of subjective task difficulty and found that, for a series of individual judgments, response latencies tended to increase as confidence ratings decreased.

Insofar as similar confidence ratings had been obtained in the present study this provided an opportunity to informally test this explanation of the extended report latencies for QL arousals. Subjects were first ranked according to the degree in which their mean report latencies under QL conditions diverged from the mean latencies for other conditions, and then a similar ranking was obtained with regard to the decrement in summed confidence ratings for QL reports as compared with confidence ratings from the other arousal conditions. A Spearman rank-correlation coefficient of .71 was obtained for the two measures, which suggests a relatively strong inverse correlation between report latency and confidence ratings for QL reports. Furthermore, a similar test of the relationship between report latency and visual vividness ratings produced an equally significant correlation coefficient of .77.

If these confidence ratings do in fact provide a relative indication of subjective task difficulty this would provide support for the explanation that the increased report latencies associated with QL arousals reflect an increased difficulty of recall or discrimination under these conditions, a difficulty which may be rooted in any number of factors -- including the possibility of arousal artifact. In addition, we might think of this as a finding interesting in its own right, insofar as it would provide indirect behavioral testimony, <u>independent of qualitative report,</u> to the

distinctiveness of recalled QL dreaming.

The findings regarding visual vividness would thus appear to hold up under these several objections and we shall consider next the implications of these findings within the context of the conceptualization of M- and Q-segment dream recall outlines in Chapter I. In this conception the qualities of dreaming attributed to the recalled "last dream event" were conceived of as a combination of veridical and of contaminated recall, with the predicted contribution of the latter determined by the relatative duration of the interrupted REM-M or REM-Q segment. Thus it was assumed that the hypothetical "veridical" nature of visual imagery during REM-M and REM-Q segments would be more closely approximated in reports upon arousal from longer segments -- ML and QL, respectively -- while reports associated with arousals from shorter segments -- MS and QS, respectively -- were expected to contain a greater degree of contamination. The difference measures ML-MS and QL-QS were thus conceptualized as indices of contamination.

Two problems of interpretation present themselves here: first, on the basis of this schema, how does one account for the fact that vividness ratings under ML and under MS conditions do not show any differences comparable to those found between QL and QS conditions? Second, can one actually say for a fact that the vividness ratings presented in QS reports are basically "contaminated"? Or, might they not represent an essentially accurate description of the quality of visual imagery at such moments in the REM period?

Explanations for the lack of differences in reported visual vividness between ML and MS conditions could be based either on the previously-demonstrated divergence of ML arousals with respect to time-of-night and prevailing level of eye-movement density; or, alternatively, on evidence reviewed by Rechtschaffen (1973) to the effect that the phasic CNS activity associated with REM-M segments usually tends to build up a second or two in advance of an eye movement burst and then continue throughout the burst. Thus, on the one hand it might be that certain uncontrolled characteristics of the ML arousals cancelled out any ML/MS differences, or, on the other hand, that with regard to the underlying patterns of phasic activation, ML and MS arousals were more similar than we previously had thought. Although both of these explanations appear reasonable, to argue for either would require that we step out of the conceptual and empirical framework of the present study, and it would be preferable to devise an explanation which is conceptually consistent with what has come before. Such an explanation, developed through a re-examination of the recall and discrimination tasks embodied in the present study, will be presented in the discussion which follows.

In introducing the notion of recall contamination in Chapter I, evidence concerning "recency judgments" from the field of memory research was used to support the assumption that increased temporal separation of contrasting dream events will lead to increasingly "accurate" retrospective judgments of their temporal order or relative recency. From this same line of research, however, has come additional evidence that the

degree of temporal separation is not the only factor which can effect judgments of recency, as the effect of actual temporal separation can be enhanced or attenuated by virtue of particular qualitative features of the items to be recalled. Fozard (1970) has demonstrated, for instance, that when picture items and word items are interspersed in a single sequence the general accuracy of relative recency judgments is lower for word-picture pairs, and particularly in those cases where the word is more recent than the picture. Further data (Fozard and Weinert, 1972) indicate that this effect is due to the general tendency for pictures to be judged as more recent than words -- a finding consistent with many other indications of the superiority of memory for visual as against verbal material (Paivio, 1969). If we adopt for simplicity the terminology of trace-strength theory, the effect demonstrated by Fozard would suggest that in general when a stronger item (eg. a picture) follows a weaker item (eg. a word) the judgment of relative recency will be more veridical than when the order of presentation is reversed. In the former case true recency and "apparent recency" (due to the greater "strength" of the picture) would summate, whereas in the latter case they would work against one another.[1]

The potential implications of this effect for the problem under discussion becomes apparent when we consider that as described in Aserinsky's hypothesis, and as supported by the present and previous findings (Herman, 1973; Molinari and Foulkes, 1969), the dreaming

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[1] This explanation is taken from Murdock, 1974, p. 70.

characteristic of REM-M segments is visually more intense or vivid than is REM-Q dreaming. We would therefore expect, by extension of the effect demonstrated by Fozard, to find that the actual order of more-visual (REM-M) and less-visual (REM-Q) items would have a differential effect with regard to the biasing of recency judgments, which in terms of the present conceptualization would translate as an attenuation or enhancement of "actual"contamination. Thus, under conditions where more-salient (REM-M) content follows upon less-salient (REM-Q) content, as is presumed to be the case in ML and MS arousals, we would expect a positive bias in recency judgments and thus less "actual"contamination than under the contrary conditions present for QL and QS arousals in which the less-salient content follows upon the more-salient.

According to this analysis we would expect to find, as we did, that thé differences between QL and QS reports are greater than those between ML and MS reports, at least with respect to the judged vividness of visual imagery. In the case of MS arousals the particularly salient qualities of vivid visual imagery would thus mitigate against their displacement by contaminated recall despite the relative recency of the last REM-Q segment. These results would imply, then, that our original conception upon which predictions of contamination were based may more adequately be stated as a two-factor (relative recency and relative salience) schema, with predictions of contamination determined by the interaction of these factors.

At this point, however, we may turn to the second issue of

interpretation introduced earlier and ask whether in fact any such concept of contamination is necessary at all to explain the present data: Could it not be that vividness ratings are just as veridical at QS as they are at QL? Although we have already described in Chapter I some of the epistemological indications for such a construct as "contamination", and have presented in the earlier section of the present chapter some observations which imply that such phenomena very likely flourish in these studies, this question nevertheless remains a valid one and calls for a more precise statement of the logical status of the concept "contamination" as used here.

It will be recalled that the present notion of recall contamination was developed as a systematic counterpart to Aserinsky's skepticism regarding the possibility of securing dream reports pertaining exclusively to either the M- or the Q-segments of REM sleep. Taking as our underlying model of REM-period dreaming Aserinsky's view of M- and Q-imagery as qualitatively discrete, we incorporated a probabilistic error-of-recall factor, "contamination", and arrived at a set of predictions concerning the qualities of imagery to be reported from arousals at various moments within the sequence of alternating M- and Q-segments of REM sleep. The hypothesized relationship between "veridical" imagery and the imagery as recalled, and the relationship of both of these to observed eye-movement activity, is represented in Figure 1. As it relates to visual imagery an upward deflection of lines 2 through 4 in Figure 1 represent some enhancement of visual imagery, whether

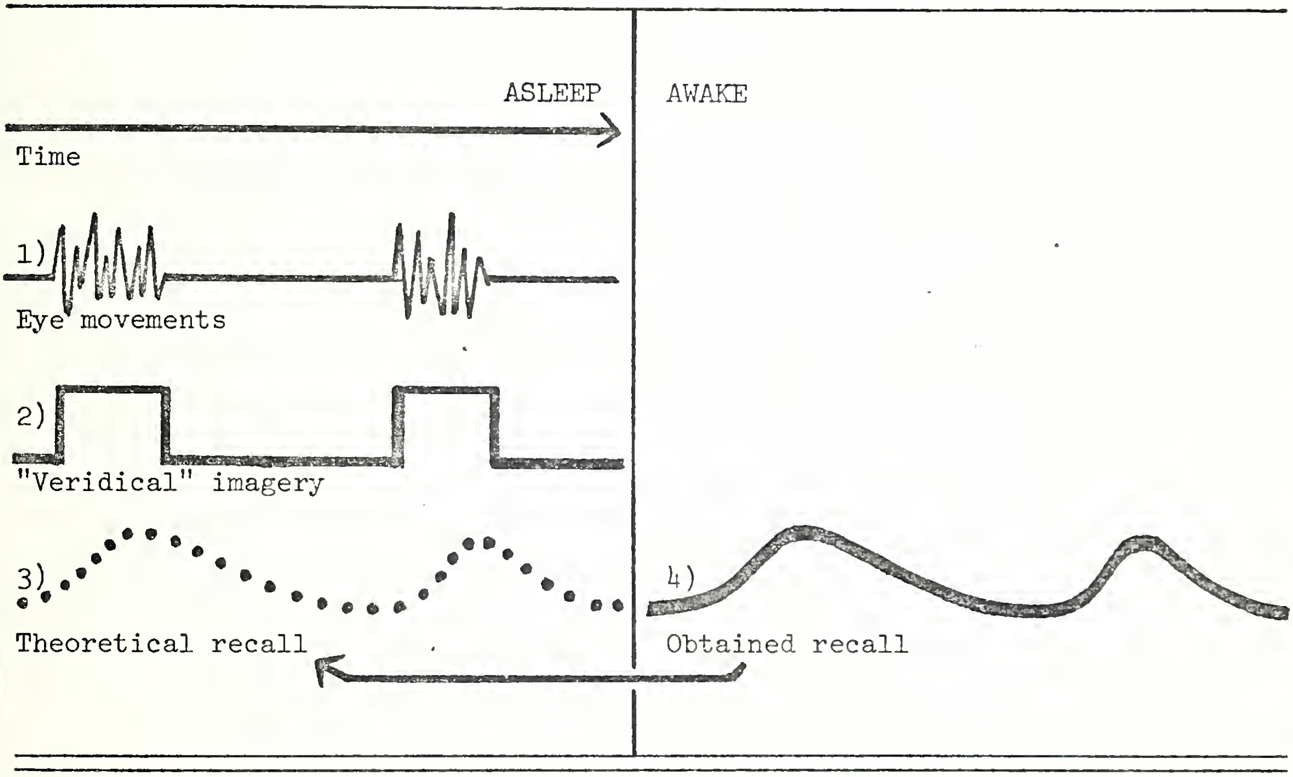

Figure 1

Schematic representation of relationships among hypothetical imagery and recall curves.

qualitative or quantitative. In this regard the square shape of the curve for "veridical" imagery (line 2) represents Aserinsky's analogy (see p. 21 above) of a T. V. set which is switched on and off at the beginning and end of a REM burst. The obtained recall curve (line 4), plotted from waking report data obtained from different moments of arousal within the REM period, has in contrast a smooth shape which represents the more gradual increase and decrease of what is <u>recalled</u> of the visual qualities upon arousal. In its reconstructed form, as the theoretical recall curve (line 3) it follows in a rough and temporally-delayed and extended manner the form of the "veridical" imagery curve. It is the discrepancy between these two curves in both shape and phase which is accounted for by the hypothetical construct of contamination.

Strictly speaking, however, the on/off notion of visual imagery represented here is an arbitrary one, and even in Aserinsky's model the sudden discontinuity of imagery implied by the analogy of a T. V. set switching on and off is rendered less absolute in his subsequent references to the "...waxing and waning..." of visual imagery during REM sleep. It may well be, then, that the "veridical" and "theoretical recall" curves are actually much closer in form and phase than the present model would suggest, and in that case the discontinuous model of M- and Q-dreaming, with its necessary corollary of "recall contamination", would give way to a <u>contextual</u> notion of visual imagery during REM sleep in which the predicted qualities of actual and recalled imagery at a given point in the REM period would be determined not by the simple fact of

its occurrence during a REM-M or a REM-Q segment, but rather by reference to its extended temporal context of previous REM-M and REM-Q episodes. In this case, the indeterminacy which we have referred to as "contamination", and which refers to presumed characteristics of the recall process, would be replaced by an indeterminacy residing in the relationship between physiology (REM-M/REM-Q) and qualities of the associated imagery.

Although this issue of the "veridical" nature of dream experience will forever elude definitive empirical resolution, a potentially worthwhile avenue of investigation pointed to by the present results would be to sample reported visual vividness at additional points in the REM period between and beyond those already examined, and provide thereby a clearer description of the recalled-vividness curve about which we have been speculating. If such a curve could be reliably established it would constitute a valuable foundation for a descriptive account of REM-period dreaming.

APPENDIX A

Subject Selection

Item 1 - Sleep Study Application Form

Item 2 - Summary of Subject Screening

Item 3 - Information for Prospective Sleep Study Subjects

APPENDIX A1

APPLICATION FORM: SLEEP STUDY SUBJECT POOL

NAME______________________________ AGE_____ SEX___

OCCUPATION__________________________________

COLLEGE______________________ YEAR_________ MAJOR_________________

MAILING ADDRESS____

PHONE NUMBER______________________

Please answer all of the following questions as accurately as possible.;

1) At what hour do you normally retire?______________

2) How many hours do you usually sleep per night?_____________

3) Do you fall asleep easily? ___always; ___usually; ___occasionally; ___rarely; ___never.

4) If you do have difficulty in falling asleep, please specify the nature of the difficulty: ____
____
____

5) In general, do you sleep... ___like a log, hard to wake up; ___soundly; ___lightly; ___so lightly as to be easily disturbed.

6) When you sleep in new or unfamiliar surroundings, do you sleep... ___like a log, hard to wake up; ___soundly; ___lightly; ___ so lightly as to be easily disturbed.

7) Do you have difficulty falling asleep in new surroundings? ___always; ___usually; ___occasionally; ___rarely; ___never.

8) Are you confused, cloudy, or disoriented when you are awakened? ___always; ___usually; ___occasionally; ___rarely; ___never.

9) Do you fall back to sleep readily after waking or being awakened during the night? ___always; ___usually; ___occasionally; ___rarely; ___never.

10) How often do you recall your dreams when you wake up in the morning?

__One or more dreams every day.
__Two to five dreams a week.
__One dream a week.
__Two to three dreams a month.
__Less than one dream a month.
__Never.

11) Do you have any current or chronic medical problems? __yes __no.
If yes, please specify:______________________________

12) Have you ever consulted a neurologist, psychologist, or psychiatrist, or received any psychological treatment? __yes __no.

13) What reason or reasons led you to apply to be a subject in this study?

____
____
____

14) Have you ever participated in a sleep study before? __yes __no.

15) Do you anticipate being out of town for any period during the month of April, 1975? If so, please specify: ______________________________

16) Do you anticipate leaving the Durham area for part or all of the summer? If so, please indicate when you plan to leave:______________________________

17) We'll need to know what your typical weekly schedule will be like during the month of April, 1975, particularly with regard to classes and other activities in the evenings and early mornings. On the schedule form on the following page place an "X" in all time slots during which you will be unwilling or unable to participate in the study. It is not necessary for you to fill in the details of your schedule, e. g. , where you will be at a particular time--we are only looking to know <u>when</u> you are not available.

time slot	Monday	Tuesday	Wednesday	Thurs.	Friday	Saturday	Sunday
12 a.m. - 6 a.m.							
6 a.m. - 7 a.m.							
7 a.m. - 8 a.m.							
8 a.m. - 9 a.m.							
9 a.m. - 10 a.m.							
*********	********	********	***********	********	*******	***********	**********
9p.m. - 10 p.m.							
10 p.m.- 11 p.m.							
11 p.m. - 12 a.m.							

***WEEKLY MORNING + EVENING SCHEDULE

(Place an "X" in all time slots during which you will be unavailable for participation in the sleep study).

APPENDIX A 2: Summary of subject screening.

I. Initial screening from submitted Sleep Study Applications:

			Number excluded
A.	Step one:	Persons under 21 excluded.	64
B.	Step two:	Persons with schedule conflicts excluded (must be available 11 p.m. to about 9 a.m. at least four days/week.	1 0
C.	Step three:	Persons reporting little or no dream recall (less than one dream per week) excluded.	2
D.	Step four:	Persons reporting significant sleep problems (as indicated in application questions 3, 7, and 9) excluded.	3
E.	Step five:	Persons with medical or psychological problems, or currently on medication, excluded.	0
		Total excluded:	79

II. Interviews with prospective subjects:

A. Prospective subjects interviewed and excluded. 4

1) Occasionally severe sleep disturbance (1).
2) Taking psychotropic medication (1).
3) Likely schedule problem (2).

B. Subjects interviewed and accepted. (6)

C. Prospective subjects not interviewed since all subjects had been hired. 3

Total applicants: 92

APPENDIX A3

INFORMATION FOR PROSPECTIVE SLEEP STUDY SUBJECTS:

This study seeks to describe psychological functioning at various times over the course of a night's sleep. In order to gather data to help us do so we employ people to sleep overnight in our laboratory and serve as subjects in our study. The subjects sleep in a comfortable bed in a darkened, sound-attenuated room, and are observed only indirectly, by means of EEG, or brain-wave recordings. The procedures for recording brain waves are totally safe and painless. On several occasions during the night, chosen partly at random, we will awaken the subject by means of a signal buzzer similar to an alarm clock, and he will be asked to give a verbal description of what, if anything, was happening in awareness just before the buzzer sounded. Following this report the subject will be asked several standard questions concerning his report, and upon completion of these will be permitted to return to sleep.

This is the full extent of the subject's participation in the study: He will not have to get out of bed during the night; no one will enter the sleeping room at any time; there are no hidden procedures or deceptions of any kind involved.

In order to gather the quantity of data we need, each subject will be required to spend a total of five nights in the laboratory. These nights will be non-consecutive, with one to three nights scheduled for each week until five nights have been completed. On the days preceding experimental nights the subjects will refrain from using alcohol, coffee, or drugs, and will report to the lab

at 11 p.m. Upon arrival at the lab, subjects will prepare for bed as usual, following which the electrodes for EEG recording will be affixed at several locations around the forehead and scalp. The electrodes we use are quite small and are attached to the skin with tape or paste. Most people quickly get used to the presence of these electrodes and fond that they do not cause any discomfort or interfere with their sleep. When the electrodes are in place the subject will receive his instructions and then go to sleep. The awakening procedures already described will be repeated about four times during the night and the experimental session will be concluded around 8 a.m. The first of the five experimental nights will be an adaptation night designed to familiarize the subject with the laboratory setting and procedures, and on this night there will be no sleep interruptions until it is time to end the session in the morning.

Payment will be at the rate of $50.00 for the completion of the five nights. If for some reason a subject cannot complete the full five nights, however, he will be paid $5.00 for each night spent in the laboratory. The reason for this is that the data will be useful to us only if all five nights are completed, so we must offer an incentive for subjects to complete the study.

All of the data gathered in connection with the study--which will include tapes and transcripts of the subjects' reports and interview responses--will be identified with a code number only, and will be treated with full confidentiality.

APPENDIX B

Experimental Procedures

Item 1 - Subject instructions, nights #2 - #5

Item 2 - Schedule of arousals

Item 3 - Post-Arousal Interview Questions

APPENDIX B1

Subject Instructions: Nights 2 through 5

Before beginning this sleep session I'd like to review with you the procedures to be followed in all of tonight's experimental arousals.

At several times during the night you will hear the arousal signal sound. When you do, awaken at once, say something like "OK" or "I'm awake", and then try to recall as accurately as possible what, if anything, you were aware of immediately before the tone sounded. Your task will be to distinguish that which was happening just as the signal sounded from whatever may have been present some seconds earlier. When you are ready to report, do so without waiting for a request from us. Describe in your own words, and in as much detail as possible, whatever it is that you recall being aware of just prior to the signal. If you do not recall being aware of anything just prior to the tone, then report just that. We are interested only in an accurate description of what you recall being aware of, and it is hoped that you will not feel compelled to report any particular type of content. Please be sure, however, that you limit your report only to what was in awareness just prior to being aroused.

When you have finished your report, let us know and we will play the pre-recorded interview questions. Please answer all questions thoughtfully and carefully, again basing your responses only on what was present immediately prior to arousal. If you have any need to communicate with us during the night, just speak out, as the mike will be open at all times.

APPENDIX B2

Schedule of Arousals

Night	Arousal	Subjects: O. Z.	S. P.	T. M.	R. T.	P. P.	C. G.
2	1	MS	QL	MS	QL	MS	QL
	2	QS	ML	ML	QS	QS	ML
	3	ML	QS	QS	ML	QL	MS
	4	QL	MS	QL	MS	ML	QS
3	1	QL	MS	QL	MS	QL	MS
	2	ML	QS	QS	ML	ML	QS
	3	QS	ML	ML	QS	MS	QL
	4	MS	QL	MS	QL	QS	ML
4	1	ML	QS	ML	QS	ML	QS
	2	QL	MS	MS	QL	QL	MS
	3	MS	QL	QL	MS	QS	ML
	4	QS	ML	QS	ML	MS	QL
5	1	QS	ML	QS	ML	QS	ML
	2	MS	QL	QL	MS	MS	QL
	3	QL	MS	MS	QL	ML	QS
	4	ML	QS	ML	QS	QL	MS

APPENDIX B3

Taped Interview Questions

1. Just prior to arousal, were you aware of seeing anything?

   a.) Rate your degree of certainty concerning whether you were, or were not, aware of seeing something, on a three-point scale as follows: 3 - very confident; 2 - fairly confident; 1 - not confident.

   b.) Just prior to the signal, were you aware of actively looking at something in particular?

   c.) Rate the vividness and clarity of what you were aware of seeing on a five-point scale as follows: 5 - as clear and vivid as if it had happened while you were awake and alert; 4 - very clear and vivid, but not quite comparable to waking life; 3 - moderately clear and vivid; 2 - not clear and vivid, but still recognizable; 1 - so vague and dim as to be just barely discernable.

2. Just prior to arousal were you aware of hearing anything, or of speaking, or, were you not aware of either?

   a.) Rate your degree of certainty concerning whether you were, or were not, aware of hearing something or of speaking, on a three-point scale as follows: 3 - very confident; 2 - fairly confident; 1 - not confident.

   b.) Rate the vividness and clarity of what you were aware of hearing or saying on a five-point scale as follows: 5 - as clear and vivid as if it had happened while you were awake and alert; 4 - very clear and vivid, but not quite comparable to waking life; 3 - moderately clear and vivid; 2 - not clear and vivid, but still recognizable; 1 - so vague and dim as to be just barely discernable.

3. Just prior to arousal were you aware of any thoughts; were you aware of thinking anything?

a.) Rate your degree of certainty concerning whether you were, or were not, aware of thinking something, on a three-point scale as follows: 3 - very confident; 2 - fairly confident; 1 - not confident.

4. Just prior to arousal, were you aware of any physical sensations? Specify whether these were sensations of bodily position, movement. touch or some other sensations.

   a.) Rate your degree of certainty concerning whether you were, or were not, aware of any physical sensations, on a three-point scale as follows: 3 - very confident; 2 - fairly confident; 1 - not confident.

5. Just prior to arousal, were you aware of any feelings or emotions?

   a.) Rate your degree of certainty concerning whether you were, or were not, aware of any feelings or emotions, on a three-point scale as follows: 3 - very confident; 2 - fairly confident; 1 - not confident.

6. Of all that you have described as being present in awareness just prior to arousal, on what would you say your attention was <u>primarily focused</u> -- was it on something you were aware of seeing? Something you were aware of hearing or of saying? Something you were aware of thinking? Awareness of some physical sensation? Or, of some emotion or feeling?

APPENDIX C

<u>Examples of EEG and EOG recordings for four arousal conditions</u>

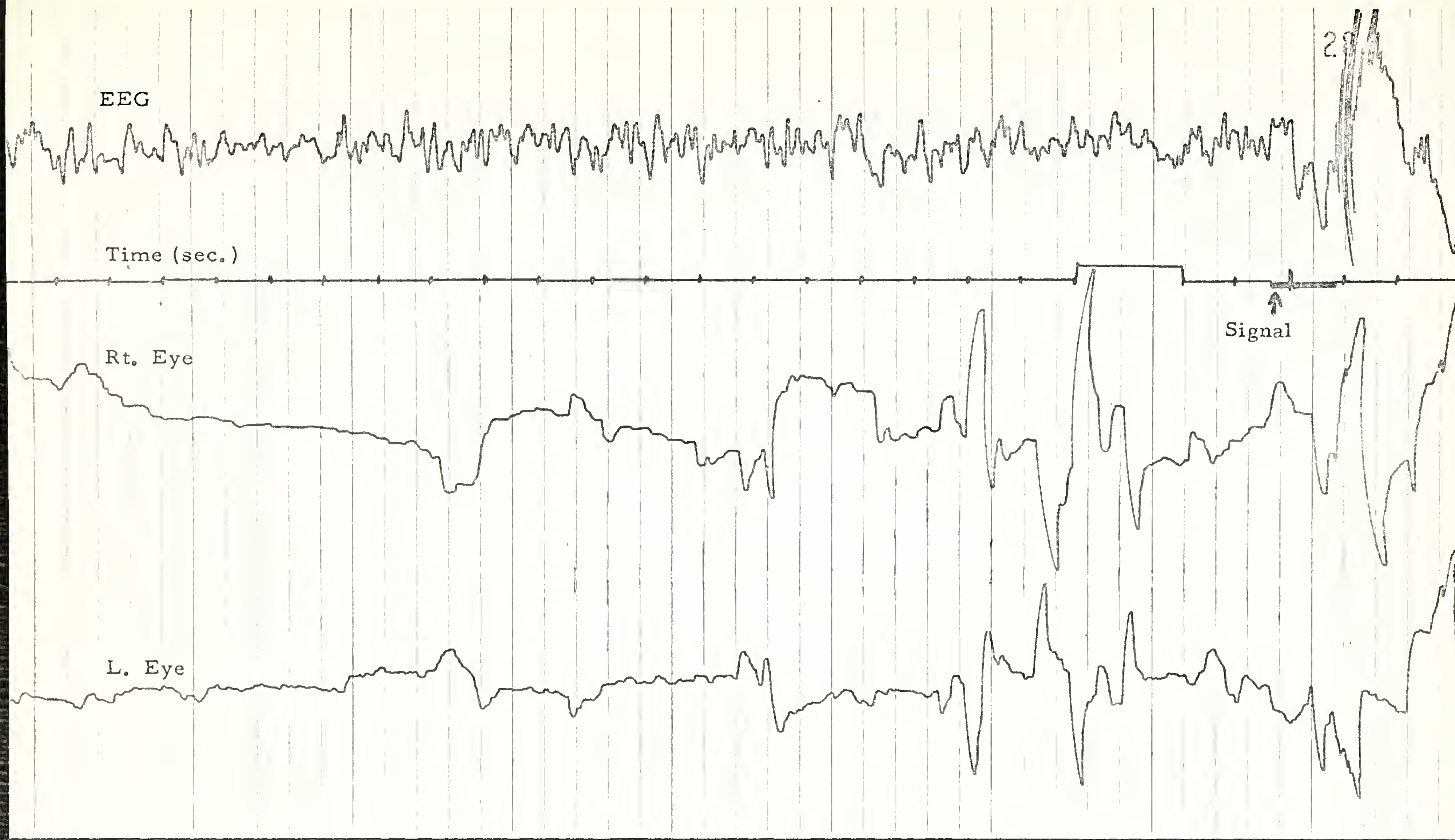

Figure 1. ML arousal. (subject P.P., night 4, arousal 1)

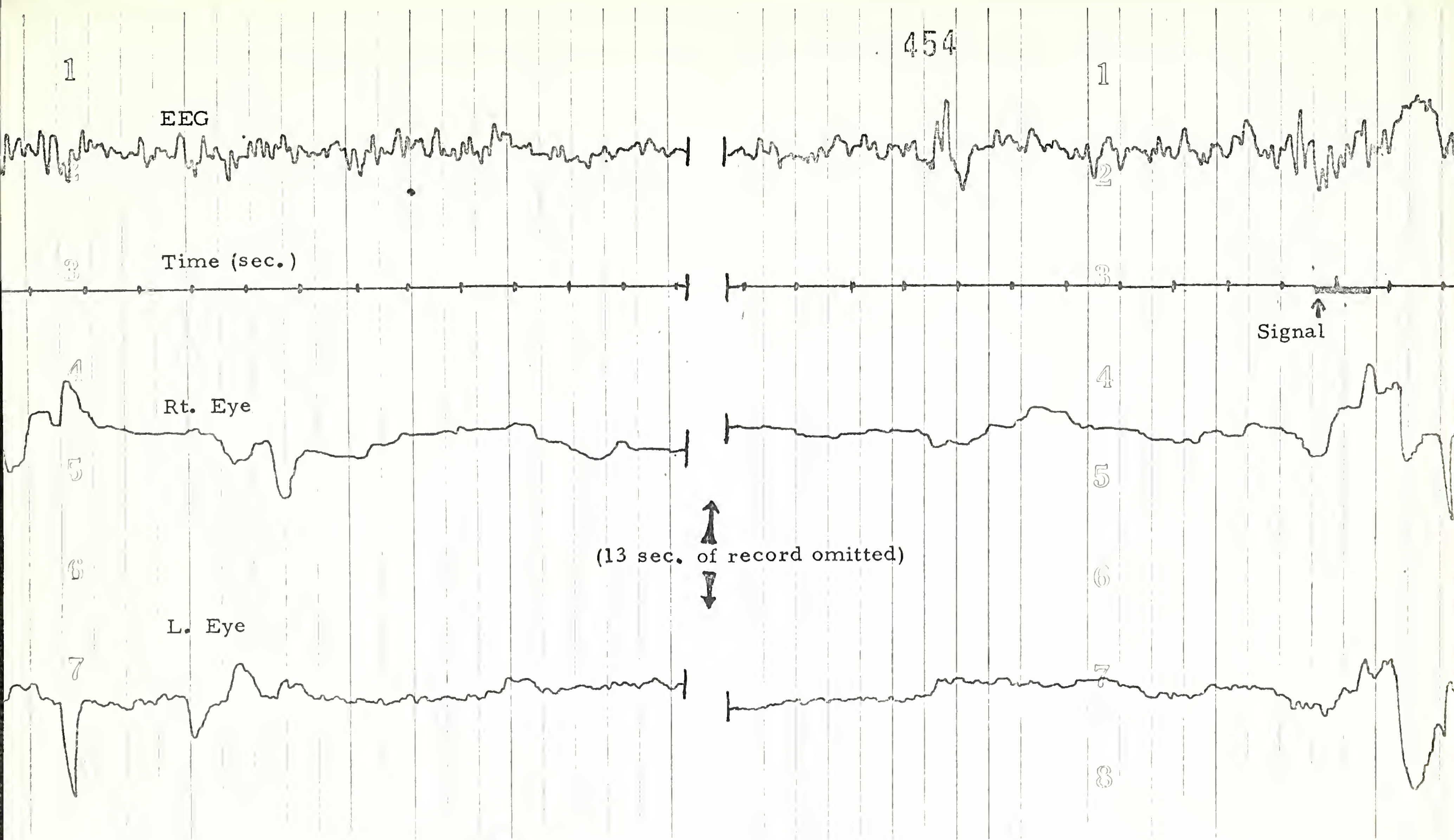

Figure 2. QL arousal. (subject P.P., night 4, arousal 2)
Section omitted contains no change in activity.

Figure 3. QS arousal. (subject P. P., night 4, arousal 3)

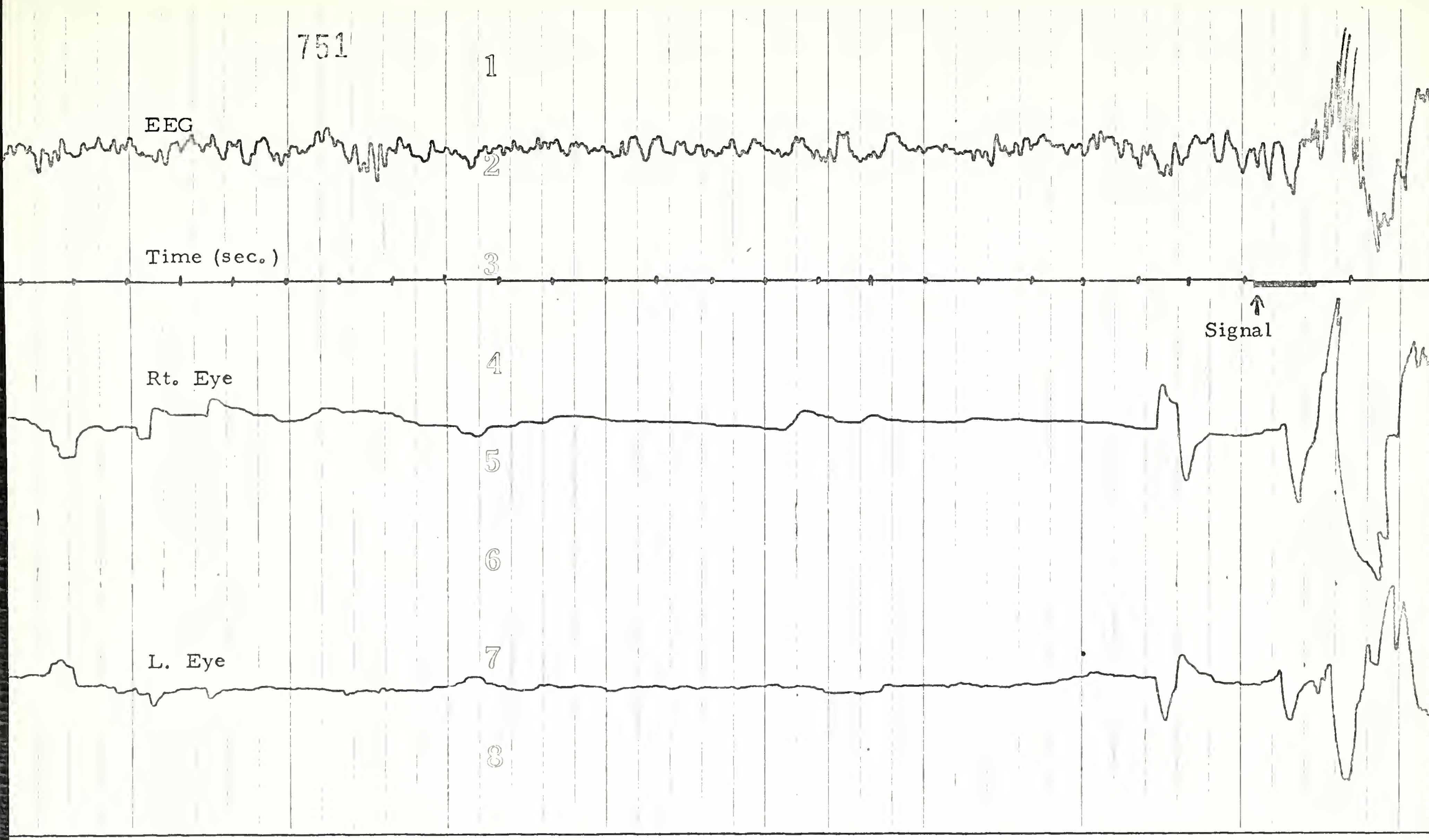

Figure 4. MS arousal. (subject P.P., night 4, arousal 4)

APPENDIX D

Quantitative analysis of REM-M and REM-Q segments

I. Determination of M- and Q-segment durations:

The eye movement data from each of 96 REM periods associated with content reports were analyzed visually into an alternating sequence of M- and Q-segments. For this analysis an M-segment was defined as a period occupied by one or more conjugate rapid eye movements, with eight seconds being the maximum interval between discrete eye movements (Aserinsky, 1971). A Q-segment was defined as an inter-eye-movement interval equal to or greater than eight seconds. Segments encompassing gross body movements or lapses from REM sleep were omitted from the M/Q classification. The length of each M- and each Q-segment was then measured to the nearest second (minimum duration= 1 second), and the resulting values were subjected to the operations which follow.

II. Durations of uninterrupted M- and Q-segments:

Table 1 presents mean durations for uninterrupted M- and Q-segments for each subject, while Figures 1 and 2 portray the distribution of M- and of Q-segment lengths for all subjects combined. In general the frequency of segment lengths tends to follow a geometric normal distribution for both M- and Q-segments, the only exception being the short

Table 1

Mean durations of uninterrupted REM-M and REM-Q segments.

Subject	REM-M	REM-Q
O.Z.	8.4 sec.	25.4 sec.
S.P.	13.4	25.6
T.M.	9.0	24.1
R.T.	8.0	29.7
P.P.	15.6	19.1
C.G.	9.6	25.6
Mean	10.7 sec.	24.9 sec.

Table 2

Mean durations of interrupted REM-M and REM-Q segments.

O.Z.	20.5 sec.	1.8 sec.	58.0 sec.	10.0 sec.
S.P.	18.5	1.3	33.5	10.0
T.M.	21.3	1.5	30.3	10.0
R.T.	20.3	2.0	34.0	10.3
P.P.	12.8	1.8	31.3	10.3
C.G.	20.0	1.8	33.0	10.5
Mean	18.9 sec.	1.7 sec.	36.5 sec.	10.2 sec.

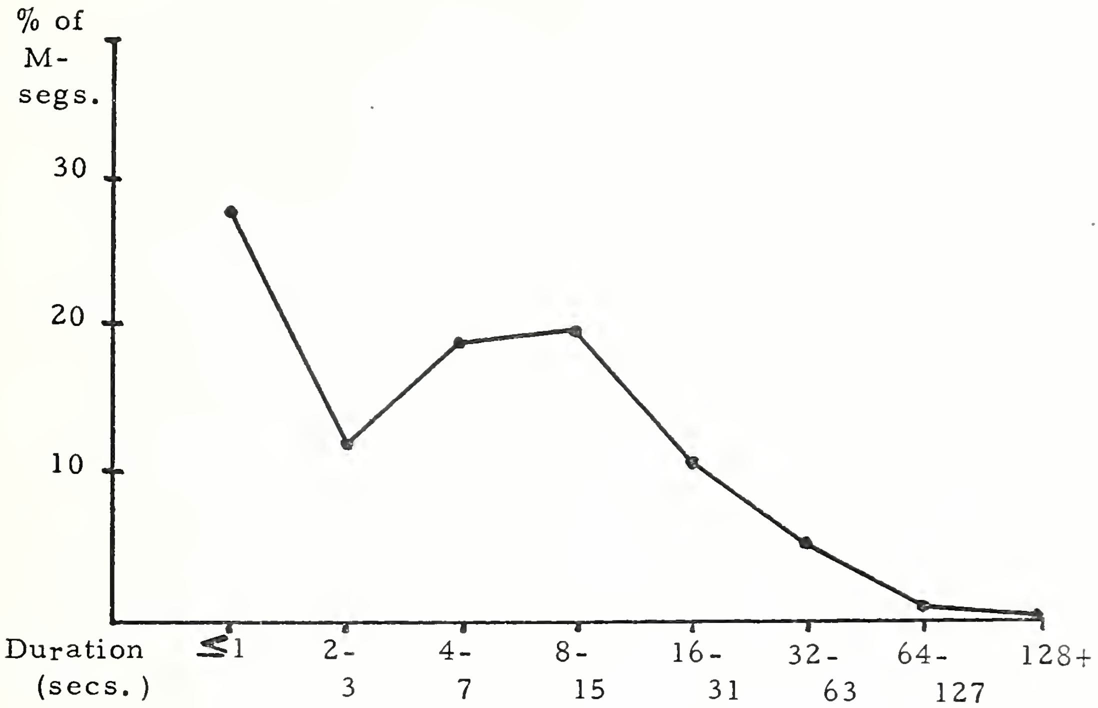

Figure 1. Duration of Ocular Motile Segments (REM-M).

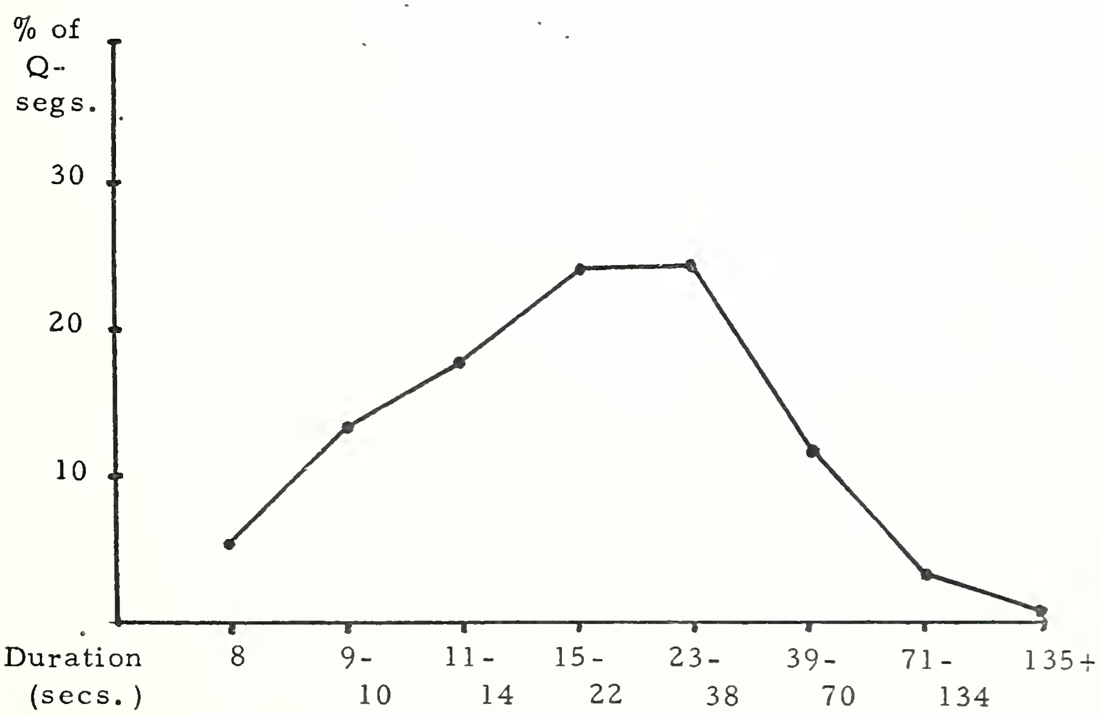

Figure 2. Duration of Ocular Quiescent Segments (REM-Q).

(≤1 second) M-segment category, consisting primarily of single isolated eye movements, which accounts for approximately 30% of all episodes of REM-M.

The data presented in Table 1 and Figures 1 and 2 diverge from previous normative data reported by Aserinsky (1967; 1971) primarily in relation to REM-M segment duration, which tends to be longer in the present study. At least two factors could account for this. First, our repeated interruptions of REM periods no doubt resulted in partial REM deprivation, which has previously been shown to increase eye-movement density in later REM periods of the night (Fiss, Klein, Shollar and Levine, 1968; Pivik and Foulkes, 1966). Second, our eye-movement data were derived from REM periods which were cut off by experimental arousal before completion, and these data thus may not be representative of eye-movement density over the entire duration of the REM period.

III. <u>Durations of M- and Q-segments interrupted by experimental arousals:</u>

Table 2 presents the mean duration of interrupted REM-M or REM-Q segments for each arousal condition and each subject. The overall means for each arousal condition can be compared with the corresponding figures for uninterrupted M- or Q-segments, and thus provide some indication of the relative dimensions of our so-called "long" (ML, QL) and "short" (MS, QS) REM-M and REM-Q segments. In table 2 we see that the mean durations of REM-M segments interrupted under the MS

and ML conditions were found to be 1.7 seconds and 18.9 seconds, respectively, and comparison of these values with the figures for uninterrupted REM-M segments indicates that the mean duration for MS arousals was <u>shorter</u> than about 70% of the total uninterrupted REM-M segments. while the mean duration for ML arousals was <u>longer</u> than about 85% of these uninterrupted REM bursts. The mean duration of interrupted REM-Q segments under QS and QL conditions were found to be 10.2 seconds and 36.7 seconds, respectively, and comparisons with the uninterrupted REM-Q data indicate that the mean duration for QS arousals was <u>shorter</u> than about 81% of the total uninterrupted REM-Q segments, while the mean duration for QL arousals was <u>longer</u> than about 84% of these uninterrupted segments of quiescence.

The figures for "short" and "long" durations of both REM-M and REM-Q segments thus appear to be fairly similar, and indicate that these types of arousals tended to interrupt the ongoing REM-M or REM-Q segment at roughly equivalent points relative to the overall distribution of uninterrupted M or Q segment durations.

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BIOGRAPHY

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